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THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

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MACHINE SHOP.

This building is one of the best structures of its kind in the country, and is equipped with the most improved tools and machinery that were obtainable at the time it was built. Its size as shown in our June issue is 258 feet 6 inches by 75 feet, two stories in height, and is as thoroughly fireproof as brick and iron construction could make it. It is a model as to lighting, all sides being provided with large mullioned windows, which are carried up as near to the top of the two stories as was practicable—a point which is very much neglected in many shops—notably so in some of the older ones. The absence of ornamentation on the outside of this and the other buildings at Juniata is also very grateful. All the construction is entirely plain, and yet is finished in excellent taste. One feature especially is noticable. All the corners which form the window and door openings are built of rounded bricks. This expedient protects them from being chipped and broken, and has a sort of soothing effect similar to that which results from the rounding of the corners of castings, which is now the universal practice with pattern-makers and designers of machinery who know their business. Some of us can remember when it was the common practice among mechanics to make as lavish use of sharp corners and mouldings in the construction of machinery which were intended to be ornamental.

The interior of the building is constructed of wrought-iron beams and columns, with fireproof floors, all of the most modern and improved character. The first floor is arranged with a central nave, with a traveling crane of 23-ft. span, which traverses its whole length, and is supported on longitudinal beams which rest on wrought-iron brackets attached to the columns. The larger machine tools are located in the center, so that all heavy pieces of work can be placed on them and taken off by the traveling crane. The shop is also liberally supplied with air-hoists and tracks on "runways," with which lighter objects can be handled with great facility. Altogether there are twenty-three such hoists on this floor. The lighter tools are located in bays on each side of the nave. The office for the foreman and shop clerk is located near the center of the shop, and is elevated so as to command a view of the whole floor. The toolroom is below it.

The motive power for the machinery is supplied by two Westinghouse 100 horse-power compound engines, and the building is heated and ventilated by the Sturtevant system. Two hydraulic elevators serve to take work from the lower to the upper floor and vice versa. Our description would assume the character of a mere catalogue if we were to enumerate the machines and tools with which the shop is supplied. As remarked before, it was the original aim to have all these of the most improved kind and that purpose has been carried out to the best of the ability of those who designed the shops. The toolroom especially is a model. The superintendent of this department also has charge of the repairs to all the machine tools in the shop, and is responsible for keeping them in order. Such a man of course should be a specialist in this kind of work, and if he is, the repairs of this kind of machinery is much facilitated.

The practice of making cutters for milling machines out of old steel axles and case hardening them has been adopted here, as well as in the locomotive repair shop, with excellent results. The axles are made of Bessemer steel.

The lighter machine tools are on the second floor, and here, too, the same superiority is noticeable. A special department, which is divided from the rest of the shop, is devoted to brass work and is equipped largely with Warner, Swazey & Company's tools.

ERECTING SHOP.

This building is similar to the machine shop and is 354 feet 6 inches by 70 feet. One of the noticeable features which is located alongside of the western entrance is an admirable wash room for the men. This has porcelain-lined basins, hot and cold water and would be a credit to any ordinary hotel. A wooden pail, which each man had to provide for himself, was all the convenience of this kind which was supplied in shops when the writer was an apprentice.

The machine tools for doing wheel-work are all located at the west end of this shop. The shafting is carried in wooden framework, so that the two traveling cranes can move over it, and they thus serve the wheel-lathes, wheel-presses, and can move the work done here to any part of the shop where it may be needed. A novelty is a wheel-press which can be raised and lowered by hydraulic pressure. Instead of blocking up the wheels in the press, the machine itself is thus brought to the proper height for the work it must do. Air-hoists are provided wherever heavy work must be lifted to or from a machine.

A single track extends through the whole length of the shop, and at the east end there are two short tracks, with pits on each side of the central one. The two traveling cranes run on wrought-iron beams, which are supported on masonry columns. The cranes are each of 35 tons capacity and can run the whole length of the shop. The office is in the middle of the building, with a room for storing bolts and other parts below it. These are all handled in wrought-iron boxes.

At the time of our visit only a small amount of work was in progress. A number of mogul engines, of the same dimensions as the compound moguls described in our October number, were in process of construction. It is the intention to substitute these engines for those of the consolidation type in many places, where the latter have heretofore been used. These moguls have Belpaire boilers, 68 inches diameter, next to the firebox, the front end being 60 inches.

BOILER SHOP.

This is doubtless one of the best-equipped shops of the kind in this country and is 386 feet 6 inches by 80 feet. The west end has a 76-foot electric traveling crane, and also five 3-ton jib cranes, operated by hydraulic power. There is also one gas furnace for heating plates, with a bed 10 by 14 feet, two hydraulic flanging presses, three hydraulic shears, six hydraulic punches, two multiple punches which will punch 70 holes at a time for tank work

and which can be changed to a 60-inch shear when required; one Sellers 5-foot straightening roll, one 6-foot small bending roll and one large 12-foot roll, all operated by hydraulic motors. All punching and shearing machines have jib cranes for handling work.

There is also a No. 5 Hillis & Jones double plate planer 20 feet long, two 4-foot Bement & Miles radial drills, one four-spindle Prentiss drill press for drilling mud rings, one hydraulic riveting machine with 13-foot gap and having a capacity for 45 tons pressure, and another one with 8 feet gap of same kind. Over these riveting machines is what may be called a clear-story which extends transversely to the building and is provided with a 10-ton hydraulic crane for handling the work to and from the machines. This crane has a lift of 40 feet above the track in the shop. Another hydraulic riveter, with a 25-foot jib crane attached to the wall, is used for riveting mud or "foundation" rings in fireboxes. There are also two "walking-cranes" which travel on a single track, bicycle fashion. One of these is operated in connection with a 60 inch gap portable hydraulic riveter and the other with a 14-inch gap riveter which has a universal joint.

Besides these machines there are two Hillis & Jones No. 1½ and No. 2 punches and shears, one flue cutting-off machine and girder, all operated by electric power; a flue tester in which water is admitted to fill the flues from the city mains and pressure applied from the hydraulic accumulator.

PAINT SHOP.

An admirably arranged paint shop also forms one of the cluster of Juniata shops. It resembles in its outfit the passenger car paint shop, which has already been described, although, of course, it is not nearly so large.

From the plan of the shops in our June issue it will be seen that a transfer table was provided for facilitating the movement of cars and engines from one shop to another. It is generally agreed now that this was not essential, and that tracks outside of the shops would provide all the facilities for transfer that are required. As has been remarked in these columns before, a transfer table is a nuisance—sometimes, it is true, a necessary one, but nevertheless one that should be dispensed with whenever it is possible to do so.

Altogether the Juniata shops may be regarded as one of the best equipped establishment in the country. The design of the buildings is especially to be commended. The lighting, heating, ventilation and drainage are all of the best, and the external appearance of the shops manifests the kind of good taste which is controlled by the highest order of utility and good sense.

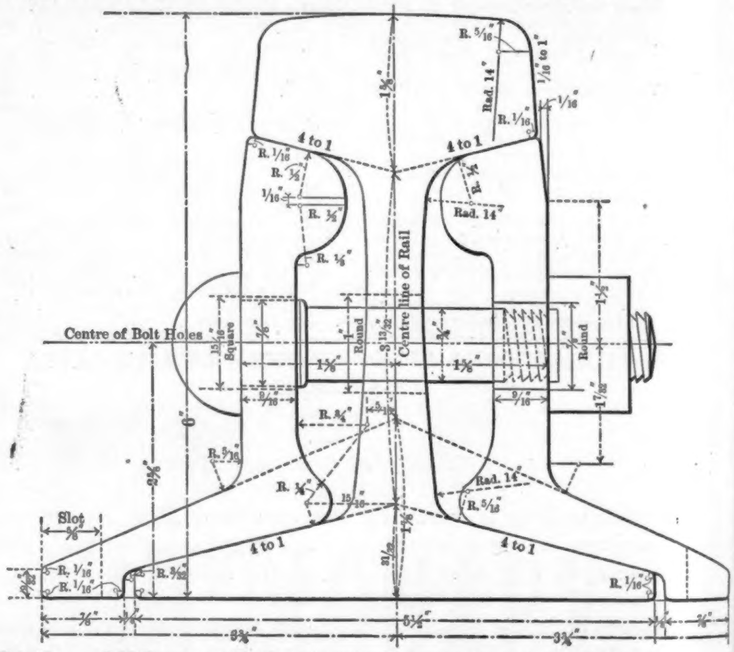
Specifications and Sections for Steel Rails and Angle Splice Bars—New York Central & Hudson River Railroad.

The New York Central & Hudson River Railroad Company is among those who have for years realized that the keeping of track up to a high standard of excellence is an important factor in providing for the greater wheel and train loads required to meet the decreasing rates of transportation. And in raising the standard of the track this company has found that nothing helps more that the use of heavy and stiff rail sections. In 1883 it adopted a 5-inch 80-pound steel rail, which is said to be the first rail section in which stiffness was made a primary rather than a secondary consideration. This same idea has governed the design of later sections including the 80 and 100-pound rails now used. The angle bars used with them are 36 inches long and the joint is supported on three ties, whereas a number of years ago the angle bars were shorter and the joint was supported on two ties. With these improvements and the use of more ballast it is found that notwithstanding the higher train speeds and heavier wheel loads, the inequalities of the track as compared with the old 65-pound rails have been decreased about 50 per cent., where 80-pound rails are used and 75 per cent. where the 100-pound rails are in service, and while this has been accomplished the expense for ties and labor has been decreased.

The improvements which we have noted above have been accompanied by the use of hard and tough steel rails of high elastic limits and the material in the splice bars is also of high-grade steel. The old-style short angle bars wore rapidly near the center of their length, but the greater length of the present standard and the better support of the joint on the ties, combined with the use of a higher steel, has reduced this wear until it is little more in the center than elsewhere, and the joints can be kept in good surface for several years with little trouble.

Mr. P. H. Dudley and Mr. Walter Katte, Chief Engineer of the road, have both given the rail question years of study and last year they got out a new specification for rails and splice bars, which, through the courtesy of Mr. Katte, we are permitted to publish. We also give sections, to a scale of one-half size, of the 80 and 100-pound rails and their angle bars.

The Dudley rail sections are already known to our readers and need no explanation. They embody the results of experience and of the best study of recent years. The heads are wide and shallow, and the metal in the heads bears such a percentage to the total as to insure proper working and a dense, compact metal to receive the wear. The angle bars are 36 inches long for all rails from 65 to 100 pounds, and are secured by six bolts. Those for the 65-pound rails weigh 54.2 pounds per pair, for the 80-pound rails, 64.3 pounds, and for the 100-pound rails, 80 pounds per pair. The



Section of 100-pound Rail and Splice Bars.–New York Central & Hudson River Railroad.

tie directly under the joint is protected by a Servis tie-plate. The specifications are as follows:

STANDARD SPECIFICATIONS FOR STEEL RAILS.

1. *Chemical Composition:*

	65 lbs.	70 lbs.	75 lbs.	80 lbs.	100 lbs.
Carbon	.45 to .55	.47 to .57	.50 to .60	.55 to .60	.65 to .70
Silicon	.15 to .20	.15 to .20	.15 to .20	.15 to .20	.15 to .20
Manganese	1.05 to 1.25	1.05 to 1.25	1.10 to 1.30	1.19 to 1.30	1.20 to 1.40
Sulphur	.069	.069	.069	.069	.069
Phosphorus	.06	.06	.06	.06	.06
Rails having carbon below will be rejected	.43	.45	.48	.53	.60
Rails having carbon above will be rejected	.57	.59	.62	.65	.70

From the results of inspections of the rolling of the ingots, blooms and rails, and from the drop tests, the Inspector of the railroad company in charge of making the rails shall have the right to select the minimum or maximum limit of either the carbon, silicon or manganese, or the three, as the general guide for the composition, as he may consider the finished product requires to produce a tough rail with as dense fine-grained heads as possible by the plant of the manufacturer.

2. *Blowing and Agitating the Heat.*—The heat to be blown clean in the stack, and, when poured into the ladle, to be agitated by thrusting a green-wood pole into the metal for 10 seconds.

3. *Teeming the Ingots.*—In teeming the ingots for rails no cracked nor patched moulds are to be used, and only a thin, even

wash of "slurry," or its equivalent, will, under any circumstances, be permitted to be used on the inside of the moulds.

The moulds must be filled without undue spattering, at one pouring, and must be maintained in a vertical position until the upper portion—top—of the ingot has solidified. Particular attention must be given to the production of sound ingots.

The steel in the mould must be made to set quiet or "dead" without the use of sand.

Occasional ingots which boil, forming "horns" in the center or corners over three inches high, or steel rising, forming "nigger heads" over three inches high, will be subject to rejection.

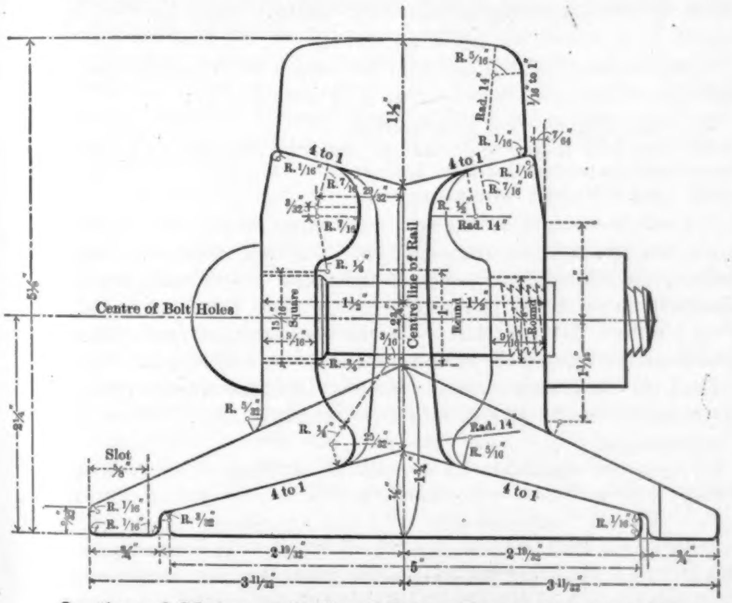
Ingots which have bled—"bleeders"—or from chilled heats, or ingots which have been badly teemed, will not be permitted to be charged into the furnaces or be used for rails under any circumstances.

4. *Test Ingots.*—From each heat, two test ingots shall be cast 2¼ inches by 2¼ inches by 4 inches long.

One test ingot taken from the metal going into the first ingot poured from the heat, shall be marked "A," and the second test ingot from metal going into the final ingot, shall be marked "B."

As may be designated, either "A" or "B" test ingot or both shall be rolled into bars one-half inch square, and pieces 18 to 20 inches long will be required to bend to a right angle without breaking.

Any form of test bar of about the size mentioned will be accepted which in bending either to a right angle or 160 degrees will stretch the metal on the outside of the bend about 12 per cent. per inch. The bars, however, must be rolled and bent by blows from a sledge or hammer.



Section of 80-pound Rail and Splice Bars.—New York Central & Hudson River Railroad.

5. *Reheating the Ingots and Blooms.*—In reheating the ingots or blooms, care must be taken to avoid overheating or producing a coarse texture in the head of the finished rail.

In no case shall they be reheated until the cinder starts to run when the ignot or bloom is drawn from the furnace or soaking pit.

6. *Cutting the Blooms.*—The sand or top end of each bloom to be cut or sheared off until sound and solid steel is obtained entirely free from sponginess, pipe or exterior scabs.

This matter must have special attention on the part of the manufacturer.

7. *Section.*—The section of the rail throughout its entire length shall conform to the template to be made in strict conformity with the measurements or dimensions on the drawing or blue-print of the section hereto attached or designated.

The fit of the fishing or male template shall be perfectly maintained.

When the rolls are new, the section of the rail must be of its standard height. As the rolling proceeds a variation not exceeding 1/64 of an inch of excess in height may be permitted in a delivery of 10,000 tons of rails in any one section, after which rolls must be reduced to the standard height for such section.

The standard of measure to be Darling, Brown & Sharpe, United States Standard steel rules.

8. *Rolling.*—The rails to be rolled at as low a heat as possible.

9. *Weights.*—The weight of the rail shall be determined by the top rail of the ingot and shall be maintained as near to standard weight per lineal yard as is practicable in conformity with the provisions in Clause Seventh.

10. *Lengths.*—The standard length of rails shall be thirty (30) feet, at a temperature of seventy (70) degrees Fahrenheit.

Shorter rails of twenty-four (24) foot lengths or over will be accepted to the extent of 10 per cent. of the entire order.

A variation in length not exceeding one-quarter of an inch longer or shorter than the above-specified lengths will be allowed.

11. *Sawing.*—The saws must be kept sharp and care must be taken in sawing to avoid a flow of steel, which will produce a swell in the center of the head or on top of the flanges of the base.

12. *Cambering.*—Rails must not be overcambered to cool; on the contrary, rails which, on a circular curve, are concave one-half inch at the center are preferred.

13. *Cooling.*—Rails when placed on the hot beds must be spaced at least 8 to 12 inches apart until cool enough to be sent to the straightening presses.

14. *Cold Straightening.*—Cold "gagging" the rails severe enough on the head or base to leave the impression of the "gag" will not be permitted. The distance apart of the supports in the straightening press must be suitable for the stiffness and section of the rail.

For the 65 and 70-pound sections, not less than 36 inches between center to center of supports.

For the 75 and 80-pound sections, not less than 40 inches between center to center of supports.

For the 100-pound section, not less than 44 inches between center to center of supports.

The supports on the straightening presses must be flat, not worn hollow, and set on the press, "out of twist," having recessed fillets in the corners.

The steel "gags" or "fullers" must have rounded, instead of sharp, corners.

The rails must be straight in all directions, as to both surface and line, without twists, waves or kinks, particular attention being given to having the ends without kinks or drops.

No rails shall be straightened until they have cooled so they can be handled with the bare hands.

15. *Finish.*—The rails must be smooth on the heads and bases, and free from all mechanical defects, flaws and seams, and must be sawed square at the ends. The burrs made by the saws must be carefully chipped and filed off, particularly under the head and top of the flange, to ensure proper fit of the splice plates.

16. *Drilling.*—Drilling for bolts to be in strict conformity with the blue print attached, or the dimensions given herewith. Holes imperfectly drilled to be filed to proper dimensions. All holes must be accurate in every respect, and finished without burrs.

17. *Branding.*—The name of the maker, date, year and month, with the designation of the rail, to be rolled on the side of the web.

The number of the heat to be stamped on the side of the web so as not to be covered by the splice plates. The rail from the top of the ingot to be also stamped "A," the second rail "B," the third rail "C," the fourth rail "D," and the fifth rail "E."

18. *Drop Tests.*—One rail butt, at least four and one-half feet long, to be taken from each heat, and placed upon skids, side by side, to cool. The heat number to be stamped upon each. If the heat exceeds nine tons, then two rail butts are to taken if the Inspector so desires.

The butts when cool to be placed, either head or base upwards, or on the side on solid steel or iron supports, and upon them shall be dropped a weight of 2,000 pounds; the height of drop and distance apart of supports for the different weight of rails being as follows:

Weights per yard.	Height of drop.	Distance apart of support.
60	16 feet.	3 feet.
65	16 "	3 "
70	16 "	3 "
75	20 "	3 "
80	20 "	3 "
85	20 "	3 "
90	20 "	3 "
95	20 "	3 "
100	20 "	3 "

Ninety per cent. of such tests must stand without breaking, and broken butts not showing an elongation of four (4) per cent. in the inch under greatest tension, the rails of that heat are to be held until a piece can be cut from one, tested under the drop, and, if it fails to show the four (4) per cent. elongation before breaking, shall subject to rejection the entire lot of rails made from that heat.

19. *Inspection.*—The Inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when

this contract is being filled, to satisfy himself that the rails are being made in accordance with these specifications. The manufacturer shall daily furnish the carbon and manganese determinations of each heat, and a complete chemical analysis of at least one heat of each day and night turn in which each element is to be determined.

20. *Rejection.*—Inspectors shall have power to reject rails made from insufficiently sheared blooms, or from heats, the test butts of which have failed, or from badly poured heats, or from "chilled" heats, or from "bled" ingots.

21. *Handling and Loading the Rails on Cars.*—Care is to be taken n handling the rails during manufacture, so as not to bruise the flanges, or throw or let the rails fall upon each o ther.

In loading upon the cars they must be skidded into them and not thrown in or allowed to fall from any height.

When rails are loaded on gondola cars with the end boards turned down, so that the ends of the rail rest on them, a wood cleat or blocking must be placed across the middle of the car to support the middle of the rail on a level with the top surface of the turned-down end board.

STANDARD SPECIFICATIONS FOR STEEL A LICE BARS FOR RAIL JOINTS.

1. *Chemical Composition.*

Constituents.	For bars not exceeding $\frac{9}{16}$ inch in thickness.	For bars exceeding $\frac{9}{16}$ inch in thickness.
Carbon	0.25 to 0.30	0.10 to 0.12
Manganese	1.00 to 1.30	1.00 to 1.30
Phosphorus not to exceed.	0.06	0.05

2. *Analyses.*—The determinations by chemical analysis for carbon and manganese shall be furnished for each heat of the steel, and similar determinations for phosphorus and silicon shall be furnished daily.

3. *Ingots.*—All ingots shall be well poured, and made so that they will set quiet on top without "sanding"; and must be of sufficient area on the top end to afford ample metal for at least 50 reductions in area, for the desired section of angle bar.

4. *Test Ingots.*—Test ingots of 2½ by 2½ by 4 inches in size shal be cast from each heat, which shall be rolled into test bars of one-half (½) inch square, and be cut into pieces of eighteen (18) to twenty (20) inches in length, which pieces must bend to a right angle without breaking; but any form of bar not less than one-half (½) inch in thickness or width will be accepted, which, when bent to an angle of from 90 to 160 degrees shows a "stretch" of the metal on the outside of the bend equal to about twelve (12) per cent. per lineal inch.

The bars must be rolled, and the bending be done by blows of a sledge hammer.

5. *Heating.*—The steel, either in ingots or blooms, must not be overheated to such degree as to cause the cinder to run when drawn from the furnace.

6. *Rolling.*—The angle bars must be rolled to shape in strict conformity with standard templates which shall be made for each of the several sizes and sections of bars required, from the dimensions shown in drawings or blue-prints of same, which will be furnished by the railroad company; particular attention will be required that the height of the bars, as determined by the fishing angle, is also at the proper distance from the center line of the rail section, as shown by the standard drawings of same furnished by the railroad company—as the proper fit of the bars to the rails depends on this feature, its strict observance will be insisted upon. The bars must be rolled with a smooth surface finish and be free from fins or cracks on the edges.

Before cutting up into splice-bar lengths the hot bars must be run upon proper hot beds, and be held in proper position to insure cooling as uniformly as possible.

7. *Branding.*—The name or initials of the maker, and date and year of rolling, also the designation of the particular rail section to which they apply, as per the standard drawings, are to be rolled upon the bevel of each bar, in such position as not to be under the heads or nuts of the bolts. Bars branded on the center line of the punching will be rejected absolutely.

8. *Shearing.*—The knives of the shears must be well and properly shaped, and at all times kept sharp and must shear clean, without tearing, cracking or leaving "fins" on the bars.

9. *Punching.*—In all bars the entire six (6) holes must be punched at one operation; and so as not to cause "swelling" in the edges of either of the fishing angles, and must be punched clean and smooth, leaving no cracks or burrs.

The punches must be set accurately in line and center-spaced in strict conformity with the standard templates made from the drawings furnished by the railroad company. The punches and dies must at all times be kept sharp and in good order.

Punching one hole at a time is absolutely prohibited, and plates so punched will be rejected.

10. *Notching.*—All the spike "notches" in any one bar must be punched at one operation, and must strictly conform, both in size and shape, with the dimensions shown on the standard drawings of the same.

11. *Inspection.*—All bars must be straight and free from kinks in any direction.

The Inspector representing the railroad company must compare all "cold templates" and gages to see that they are in strict conformity with the dimensions given by the standard drawings for any section; and any template or gage not so conforming must be re-adjusted or replaced; and any heat of steel or splice bar found by him not to be in conformity with every requirement of this specification shall be rejected by the said Inspector.

The Maintenance of Iron and Wooden Underframes of Freight Cars in France.

BY M. L. TOLMAR,
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CHIEF OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE AT MOHON (ARDENNES).

The railroads of Continental Europe possess a great variety of rolling stock, many of which are to be seen not only in passing from one country to another but even on the railroads under the same administration. In excepting the passenger coaches and the accessory cars for fast schedules (luggage vans, cars for equipages, for stabling, etc.) as well as the special cars such as refrigerator, tank, etc., there remain in France about 250,000 cars, the maintenance of which will be the subject of this article. Nearly all these cars present the following features:

1st. The frames rest directly on the wheels without the intermediary of bogies or trucks. They have in general two pairs of wheels, about one meter (39.4 inches) in diameter, and these support the weight through the medium of half-elliptic springs.

2d. Their lengths vary between 4.5 meters (14.8 feet.) and 8 meters (26.2 feet), and their carrying capacity is 10,000 kilograms (22,000 pounds), while the weight is between 6,000 and 9,000 kilogrammes* (13,200 pounds to 19,800 pounds).

3d. Their draw-gears have either spiral or high-elliptic springs.

None of these cars have continuous brakes, but about one-tenth of them are furnished with hand-brakes.

CLASSIFICATION.

From the standpoint of the materials employed in the construction this rolling stock may be classed in three groups:

1st. Cars with wooden underframes.

2d. Cars with mixed underframes (longitudinal sills of iron and transverse members of wood).

3d. Cars with iron frames.

We will mention that frames of wood reinforced by iron plates are in use, but their numbers are few. The Eastern Railroad has only applied these plates to permit the use of the Westinghouse air-brake on some old passenger coaches with wooden frames. Four hundred flat cars have likewise been supplied with iron plates for reinforcing the sills at the middle of their length.

Each of the groups enumerated above includes cars of several types, which can be divided into three principal ones:

a. Flat cars.

b. Open cars with high sides, with or without doors, for the transportation of coal, coke, minerals, etc.

c. Closed cars.

Taking as a basis the rolling stock of the Eastern Railroad, we can establish the following table, from which we can obtain an approximate idea of the general division of the rolling stock of France in the preceding classification.

Designation of groups.	Flat cars.	Open cars with high sides.	Closed cars.	Totals.
Cars with wooden frames	3,212	3,632	2,903	9,747
Cars with mixed frames	614	2,685	1,198	4,497
Cars with metal frames	5,205	3,898	6,334	15,437
Totals	9,031	10,215	10,435	29,681

GENERAL DESCRIPTION AND MAINTENANCE OF THE GENERAL TYPES.

Running Gear, Draw Gear and Brakes.—The progress realized in the lubrication of journals and the construction of wheels, the different requirements that the administrations are obliged to meet to facilitate the exchange of cars, often compel them to modify various parts of the running gear and draft gear. The expense involved in these changes is often confounded with the cost of maintenance, properly so called. There is little of interest in this question, which is after all outside of the limits of the present work; the same may be said of brakes.

Boxes.—The boxes entirely of wood appear to be abandoned more and more for the new rolling stock with high sides, as this

* At present new cars are constructed to carry 15,000 kilogrammes (33,000 pounds). Several companies are adopting cars of 20,000 kilogrammes (44,000 pounds) capacity.

class of rolling stock is subjected to severe usage, being often loaded from wagons whose contents are dumped into the cars from a considerable height.

The first attempt to use iron upper frames (that is, frames for holding the sides and ends) were not very successful, the sections being generally too light. At last to obtain boxes of light weight and small cost they sacrificed solidity and facility of repair. Oxidation, together with the wear of service, have prevented them from being more durable than the boxes made entirely of wood.

To-day, at the risk of increasing the dead weight, they have adopted stronger sections, of which one can judge by examination of those represented in Fig. 1. It would be difficult to say in advance what ratio there will be between the durability of the first and of the last types, but we can without hesitation admit that the advantage will be with the new sections.

The repairs necessitated in running service are almost always from accidental causes and consist in uprights or moldings (upper bands) worn or broken. It is not usually economy to repair these parts—they are simply replaced by new pieces prepared in advance. This work is facilitated in many cases by having the pieces secured by bolts* and not with rivets, so that there is no difficulty in substituting one piece for another.

Boxes entirely of iron are, with the French companies, used only in exceptional cases. The Belgium and German roads are abundantly supplied with them. The running repairs of such boxes are certainly less than boxes whose sheathing is of wood, until the time when it is necessary to replace the sheathing or repair the under parts weakened by rust, which collects rapidly. In case of serious damage resulting from a collision or derailment, the repairs afterward are very expensive. We have found a number of times that the cost of such repairs has been more than 25 per cent. of the purchase price, while that for cars with wooden ends and sides (upperframes of iron or of wood) under the same conditions would not have reached 10 per cent. This work of repair requires a very complete set of tools and a staff of skilled workmen, such as iron workers—seldom found except in shops of considerable importance.

Several administrations such as the Eastern and Northern railroads have kept in their equipment some covered cars with boxes entirely of wood. These cars do not have to resist as heavy strains as do the open cars with high sides which transport full loads of heavy material; the use of iron sections for the upperframes is thus less needful, and when we arrive at this condition, we may remain content with light sections. As in the case of the uncovered boxes, it is difficult to give an opinion of the advantages of wooden upperframes over the iron ones, or vice versa. In discussing it, we find that it raises very complex questions relating to the kind of traffic, the circumstances under which one finds himself, the traditions of the owning administration, etc. We do not believe it possible to reach an actual conclusion in such a discussion.

We give further on a series of designs representing cars of which the boxes belong to the different types of which we have spoken.

Underframes.—Although the cost of an underframe is only one-tenth of the total cost of a car, this part is to be considered the most important. It is admitted that the duration of the frame is the same as that of the car itself, and that the repairs it requires correspond almost always to the repairs of the box.

The frame is far from being subjected to the complex conditions which govern the establishment of a type of car; it is simply required to be of small cost, substantial and easily maintained. For this reason each grand administration limits itself to a small number of types of frames, while admitting a very great diversity of types of boxes.

The question of knowing if it is preferable to construct the underframes of wood or to introduce steel sections presents itself with a special distinctness that makes it interesting to examine.

The frames of wood are almost always of the rectangular outline (Fig. 2) *A B C D*, braced here and there by intermediate transverse members, and rendered rigid by diagonal bracing. These various pieces made of oak are joined by means of gussets, knees or brackets, and iron plates, and the guard plates (pedestal jaws) are fastened directly on the sills.

As a rule these frames deteriorate continually in consequence of the working of the joints and the shrinkage and checking of the wood, and finally by the decay at the mortises and tenons and the different holes for bolts, screws and hook bolts. As a result of unusually severe pulling and buffing shocks the transverse members break and finally the diagonal bracing and the sills fracture. When these last resist the shocks, they finally become considerably bent and drop so much at the ends as to lower the buffer below the required height and to interfere with the working of the doors. If the repairs are frequent they have the advantage of being easily made by very ordinary carpenters who can be found anywhere. About 30 years ago the proportion of carpenters in the shops was greater in comparison with workmen of other trades than is the case to-day.

The mixed underframes (Fig. 3) differ from the wooden frames only in the adoption of iron sills of *I* section. The running repairs of these frames can be made with the same facility as the wooden frames except, of course, when the iron sills are affected in consequence of serious accident.

The frames, entirely of iron, are usually made upon one of two different types.

One of these (Fig. 4) exactly reproduces the form of the wooden frame, the parts being replaced by metallic pieces. The adoption of channel iron sections in the rolling stock of the Paris-Lyons-Mediterranean Railroad facilitates the attachment of the pedestal plates, which may be made of plate-iron simply cut out to the form required (Fig. 5); besides the intermediate transverse members can be replaced without it being necessary to separate the box from the frame.

The other type (Fig. 6) is designed on entirely different lines from the wooden frames. The diagonal bracing is done away with, and the rigidity of the frame is obtained by corner gussets *A*, *B*, *C*, *D* and by a sufficient number of intermediate transverse members of a larger section than in the preceding case. This type, which is the principal one of the Eastern Railroad of France, employs I-beams for the sills, has greater rigidity than the preceding design, but does not permit the intermediate transverse members to be so easily replaced. On the other hand, it is better adapted to be machine-riveted, and this gives it greater durability. The floor-stringers, *F F*, *G G*, give solidity to the system and serve to sustain the flooring. Those placed near the longitudinal axis of the frame receive directly the strains from the draw-gear and transmit them to the frame.

The type of frames represented in Fig. 7 does not lack interest, for it partakes of the nature of both of the preceding types; it is this type which seems to us to give the best resistance in case of collision.

Contrary to the experience with wooden or mixed frames, the iron frames are affected but very slowly by oxidation that endangers their solidity.* We have never been able to prove, even in shops where about 30,000 cars a year are repaired, that damage to the frames was attributable to the disappearance of rivets or the premature weakening of the sections by rust.

A fear of the consequences of the breaking of rivets is, nevertheless, often expressed by persons, who base their opinions on that which takes place with metallic bridges. There is in reality no comparison between the joining of parts belonging to a bridge and those of car frames. In the case of a bridge the rivets of the bracing connecting the beams evidently work scissor fashion as these braces take the rolling loads; in the case of the car frame the load is principally on the sills, themselves forming beams, and the bracing serves chiefly to maintain the spacing of said sills, thus giving the rivets very little strain of the scissor kind. The damages produced are principally to the iron sections of which the frame is composed.

* The use of rivets is frequently insisted upon by the customs to avoid the too easy taking apart of the box, thus permitting fraud.

* See article published by the "Revue Generale des Chemins de Fer," of which the translation was published in this journal for August, 1896, under the title of "The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes."

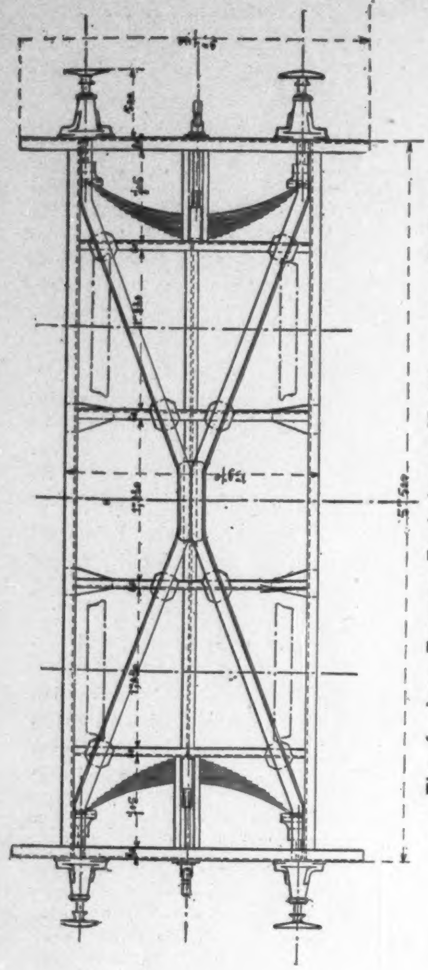


Fig. 4.—Iron Frame.—Paris-Lyons-Mediterranean Railroad.

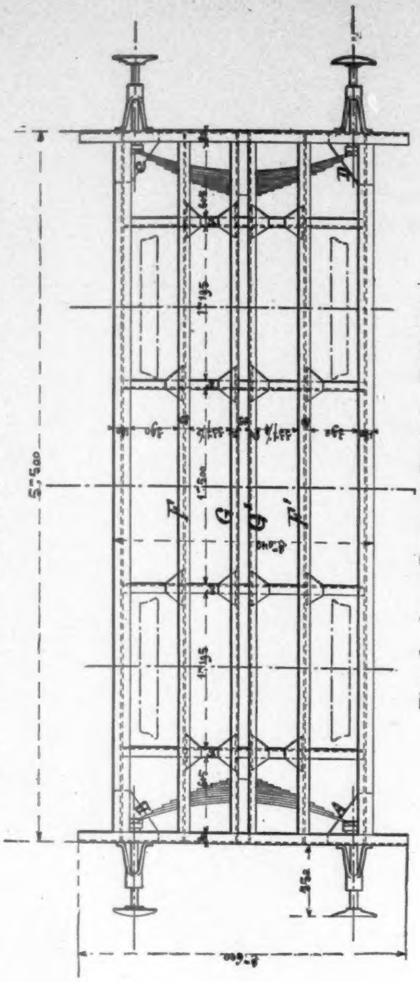


Fig. 6.—Iron Frame.—Eastern Railroad.

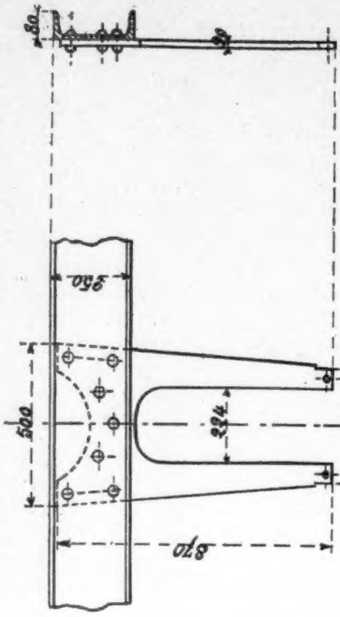


Fig. 5.—Pedestal Plate.—Paris-Lyons-Mediterranean Railroad.

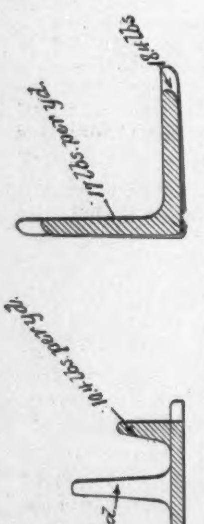


Fig. 1.—Comparison of the Old and New Sections Used in the Construction of Upper Frames.—Eastern Railroad.

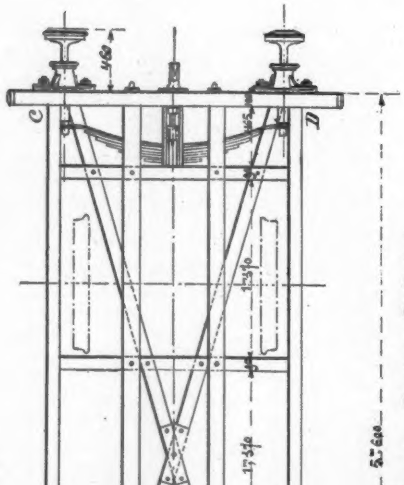


Fig. 2.—Wooden Frame.—Eastern Railroad.

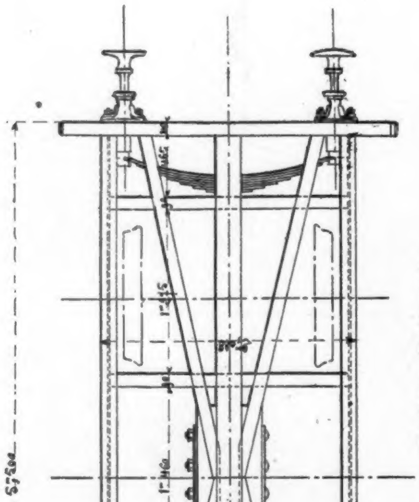


Fig. 3.—Mixed Frame.—Eastern Railroad.

THE MAINTENANCE OF WOODEN AND IRON FRAMES OF FREIGHT CARS IN FRANCE.

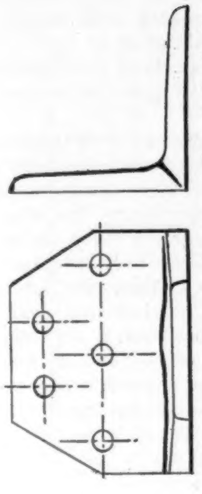


Fig 9.—Fracture in the Corner Irons or Brackets between the Sills and Transverse Members.

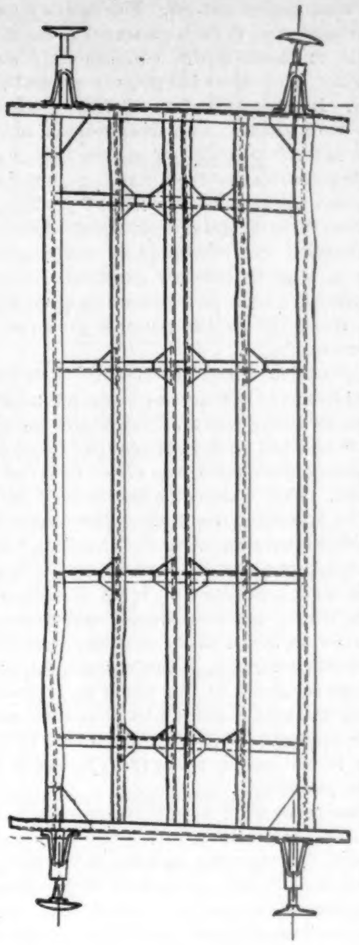


Fig. 10.—Diagram Showing the Deformations of Iron Frames on the Eastern Railroad as the Result of Collision.

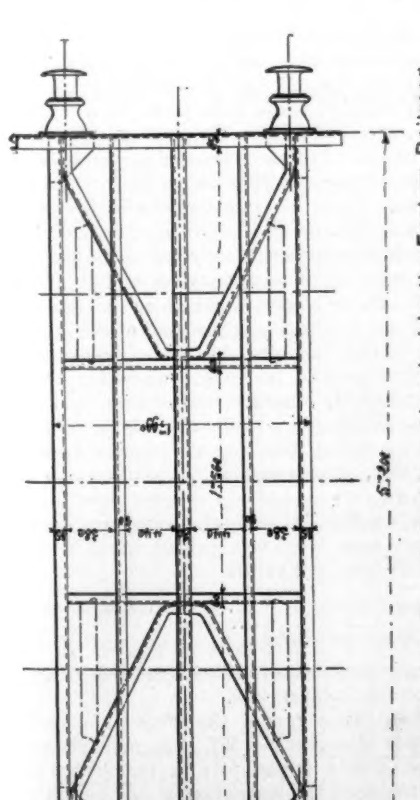


Fig. 7.—Iron Frame Used by One of the Lines Absorbed by the Eastern Railroad.

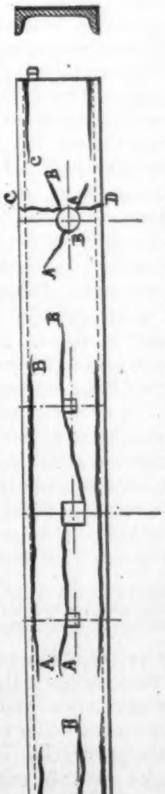


Fig. 8.—Fractures in the End Sills of Iron Cars, Eastern Railroad.

NOTE.—Center hole is for drawhead, adjacent holes for safety chains, and outer holes for buffers.

We have seen some end sills split along lines such as *A B* (Fig. 8) in consequence of abrupt starting or stopping of trains, but these fractures occurred in the earlier sills made of iron and not of the late steel sills; furthermore, the rolling of the iron had been badly done, there being open seams where the iron had failed to weld, which opened up under the shocks of service. Other damages, such as *C D*, and they are the most frequent, are produced in switching—it may be on a bad private crossing or against a platform buffer.

Some corner brackets joining the transverse members to the sills have been found broken at the angle (Fig. 9). The damage was of little importance, and was attributed to the fact that the iron corners presented defects of rolling that would not have existed with steel, which alone is used to-day.

All other damages to the frames proper (deductions made for accessories, such as steps, hooks for switching at stations by means of horses, etc.,) have been the result of exceptional accidents—collisions, derailments, fires, etc.

It is noticed that in collisions the cars of wood placed in between cars of iron are often entirely destroyed while the others have suffered only insignificant damages. In case of collision the deformation of the frame, especially the new ones, are almost always of the same character—the joints resist, the members are more or less bent or broken, but continue to cross each other at right angles. (Fig. 10.)

The repairs are made by taking the entire system of framework apart and straightening the irons, repairing or replacing those which are broken, then putting the frame together again, usually with the same gussets, corner brackets, etc. Replacing sections presenting a slight crack is generally the most economical procedure, but it occasionally happens that it is preferable to patch the damaged part, as, for example, when the section is special and not readily purchased in the market. The straightening of twisted irons has always been done with heat in our shops. Formerly they used a fire (often of wood) on a forge, but now we use gas burners receiving a proper mixture of air and coal gas, which permits us to heat the section at a desired point without having then to manœuver to get it to a press, and, sometimes even without having to take the frame apart. This method, which was recently adopted in our shops, will probably permit the greater part of the repairs to be made by very ordinary workmen, and a limited amount of apparatus of the cheapest kind.

At present these works require fitters, blacksmiths and riveters pretty well trained, and which can only be found in shops of importance. The French railroad companies have shops equipped for the rolling stock only, in which from 300 to 400 workmen are employed and who are at times occupied in constructing new cars when the repairs do not keep them busy.

In those shops where they do in general the work required on passengers cars, the proportion of ironworkers is much larger than formerly and conforms nearly to the following list:

100 ironworkers.
50 operators of machine tools (for ironworking).
50 carpenters or joiners.
20 operators of woodworking machine tools.
30 painters, upholsterers and glaziers.
20 blacksmiths.
30 blacksmiths' helpers.
50 expert workmen: toolmakers, mechanicians, cabinetmakers, etc.

350 total.

With the exception of the blacksmiths and the expert workmen, which are sometimes difficult to find, and who are paid about 30 per cent. higher wages, all the others can be easily obtained in any industrial community. The daily wages in France (provinces, is from four to six francs (80c. to $1.20) for 10 hours' work.

(*To be continued.*)

The Philadelphia Ledger of Feb. 15 prints a dispatch from Pittsburgh, which says that British makers of iron and steel products are alarmed by the invasion of their home markets by American manufacturers. It is stated that tin-plate bars have been exported to the Welsh tinned plate mills for several months, and that some of the tinned plates imported recently were made out of American steel. Bessemer steel billets have been exported, and one Pittsburgh firm is reported to have been recently shipping on an order for 20,000 tons of billets, which have been landed on the west coast of England, at a price of 12 shillings below the local price. Other forms of iron and steel exported extensively are hardware, mechanical tools and various forms of machinery.

Notes From Work Done on the Chicago & Northwestern Locomotive Testing Plant.*

BY E. M. HERR.

The locomotive testing plant installed in the Chicago shops of the C. & N. W. Ry., under the direction of Mr. Robert Quayle, Superintendent of Motive Power and Machinery, consists briefly of three pair of flangeless supporting wheels, 51 inches in diameter, mounted on eight-inch axles, supported in pillow blocks, with 8 by 6-inch bearings, the axles extending through the bearings far enough to receive on each end a cast-iron flangeless chilled face brake wheel 33 inches in diameter, enclosed in a sheet-iron tank. A steel brake band encircles each brake wheel, under which cast-iron brakeshoes are placed. These brakeshoes are drawn against the wheel by tightening the brake band by means of a lever actuated by an air cylinder securely bolted to the pillow block frame. Water is admitted at the bottom of each brake wheel tank and overflows near the top, so that the brake wheel is always immersed in flowing water. The locomotive to be tested is placed upon the supporting wheels with one driver exactly on top of each of these wheels (only two pairs being used for four coupled engines), which are first adjusted to the wheel base of the engine by moving the pillow blocks as required on bed plates, which are securely bolted to a heavy timber foundation. The locomotive is then securely connected by means of an adjustable drawbar to a post amply braced and secured to resist the heaviest strains that the tractive power of the locomotive can exert. Provision is made for supplying and at the same time measuring accurately the fuel and water used while the engine is working under any required speed and power. The smoke and gases from the stack are carried outside the building in which this plant is located by means of a large uptake provided for this purpose. The speed of the locomotive is controlled entirely with the brakes operating on the brake wheels mentioned above. This is done automatically by attaching an ordinary ball governor to the pipe carrying the compressed air to the brake cylinders. This governor is belted to one of the supporting axles, and is provided with a series of pulleys of graduated sizes, arranged to give any required speed from 10 up to 60 miles an hour by admitting compressed air to the brake cylinders only when the required speed is reached, thus applying the brakes and making it impossible for the engine to exceed this speed. The heat generated by the friction of the brakeshoes on the wheels is carried off by the water in which these wheels are immersed, which at the same time serves, to a certain extent, as a lubricant between the brake wheel and shoes, thus keeping the friction more constant than would otherwise be possible. A "Boyer" speed recorder, also belted to the axle, indicates and records the speed. "Bristol" continuous recording gages, continuous and other revolution counters, calorimeters, indicator piping and pantagraph reducing motion are provided and used as necessity or occasion requires. This plant was originally installed primarily for the purpose of breaking in engines just out of the shops, and only secondarily as a device for testing their performance and efficiency. The latter use has been found so valuable, however, that most of the work done on the plant has been experimental.

The results obtained in breaking in locomotives for road service on this plant have not been as uniformly good as could be desired. There is no difficulty in breaking in the driving box bearings themselves and the rods and pins with entire success, but owing to the uniform position in which the engine stands while running it is not possible to have the bearing surfaces on all driving wheel hubs worn down to a perfect bearing. We have found in locomotives broken in on this plant that while all eccentrics, crank pins and other rod bearings, links, rockers, and in fact all bearings, except ing driving boxes, run perfectly smooth, the latter often do not, which is probably to be attributed to heat from the hubs, as the bearings which give trouble on the road ran as cool on the plant as the others. It is on this account as well as from the fact that so much important experimental work has developed that the plant is now being used almost entirely for testing.

It is my purpose to give a brief account of the most important work which has been done on this testing plant since its installation, about eighteen months ago. The first work undertaken was an investigation of the effect upon the performance of C. & N. W. engine No. 19, a 17 by 24-inch engine, with 16 square feet of grate surface and 975 square feet of heating surface, of different amounts of inside clearance in the valve. Fifteen tests were made, at speeds between 25 and 45 miles per hour, and at about six, seven and nine inches cut-off. The inside clearance varied in these tests from zero to 5-16 inch clearance. Each test was run from two and a half to three hours continuously, and at rates of combustion ranging from 62 to 135 pounds of coal per square foot of grate per hour. Incidentally four different kinds of Illinois and Indiana coal were tested. The evaporation of the Indian coal at rates of from 62 to 65 pounds per square foot of grate per hour, from and at 212 degrees, varied from 8.25 to 9 pounds water per pound of coal. Illinois coal varied from 7.5 to 8 pounds, with rates of combustion of from 68 to 90 pounds per square foot of grate. At higher rates of combustion the efficiency of evaporation decreased quite rapidly, with a slightly inferior grade of Illinois coal, being as low as 6 pounds of water per pound of coal, when the rate of combustion was from 125 to 135 pounds per square foot of grate per hour as shown in Fig. 1.

The coal per horse-power hour varied with the power developed, being least for low horse-power, about 250, and greatest for powers above 450 horse-power. The entire range lay between the extremes of 3.55 and 4.61 pounds of coal per horse-power per hour. The highest power developed was 477 at 43 miles per hour and seven inches cut-off. This was easily maintained for two and a half hours and was by no means the limit of the power of the engine. The effect of inside clearance upon the shape and area of the indicator cards at a speed of about 150 revolutions, or 30 miles per hour, is shown by cards not reproduced. With the exception of one end of two cards, which are considered rather anomalous, there is almost no variation in mean effective pressure with a gradual cutting out of the inside clearance of the valve from line and line to $\frac{1}{16}$-inch clearance on each side at this speed and cut-off. What is lost by the earlier exhaust is gained by the later compression. The efficiency of the engine in water per horse-power per hour also shows very little if any loss, it being from 25.5 to 26.5 pounds water per horse-power per hour.

These tests were supplemented by a series of 21 others with engine No. 567, another 17 by 24-inch engine, with a slightly larger grate, 17.5 square feet and the same amount of heating surface as engine No. 19, viz., 975 square feet. They were undertaken with a somewhat wider range of speed, viz., from 16 to 46 miles per hour They confirmed the results of the former series at the higher speeds, but at the lower speeds both the economy and power of the engine decreased when the valves were given inside clearance. Fig. 2 shows the performance in this series of tests.

Still another series of four tests were made on engine No. 797, a 19 by 24-inch ten-wheel engine, with 26.9 square feet of grate and 1,545 square feet of heating surface. These tests were run at speeds of 16 and 35 miles per hour, with 3-32-inch inside clearance and line and line valves. Here the line and line valve showed the greatest at 16 miles per hour and about the same at 35 miles per hour, while the efficiencies were the reverse. These tests owing to some errors in observations are unreliable as data on locomotive performance, but they brought out a very important point in locomotive design, not often fully appreciated. I refer to the importance of stiff and rigid eccentric rods. Engine No. 797 had long, crooked eccentric rods, such as are usually found on 10-wheel engines, and of about the ordinary stiffness. It was found, however, that these rods sprung so much and so irregularly as to make it almost impossible to obtain duplicate indicator cards with absolutely no change in conditions. A decided improvement has been made by making the rods "I" section and this is now being done on all engines passing through the shops for repairs. The evaporating performance in these tests is given in Fig. 2.†

As a result of these tests, checked by as careful comparative records of actual road performance as could be obtained, the following practice has been adopted on standard valves:

For through high-speed passenger service..........	$\frac{1}{8}$-inch inside clearance
" local passenger service..........................	$\frac{3}{32}$-inch " "
" suburban passenger freight and switching....0	" "

The valves of the passenger engines have also longer outside laps than those of the freight and switch services.

The next work undertaken was a test of the effect of a smoke burner on the boiler efficiency of engine No. 597. The tests showed that the prevention of smoke with steam jets in the firebox as arranged on this engine reduced the evaporation per pound of coal.

A feed water heater was tested on this same engine, but no advantage in economy was found by its use in several careful tests. The water per horse-power hour and the evaporation per pound of coal within the errors of observation were almost absolutely identical with the results obtained with the engine run in exactly the same way before the heater was attached. This, of course, only proves

*From a paper before the Western Railway Club.

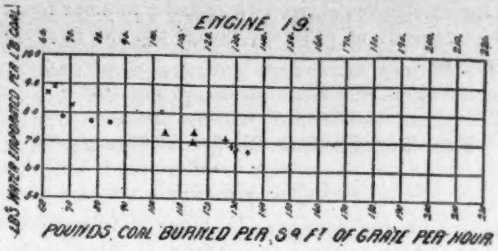


Fig. 1

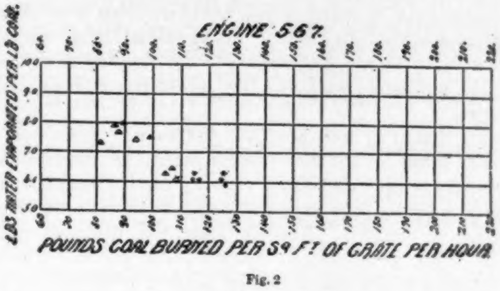


Fig. 2

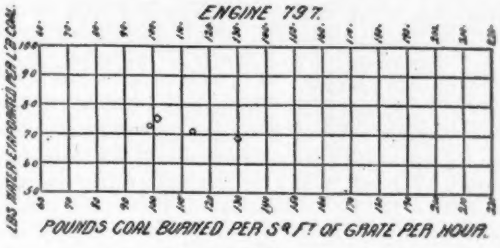


Fig. 3

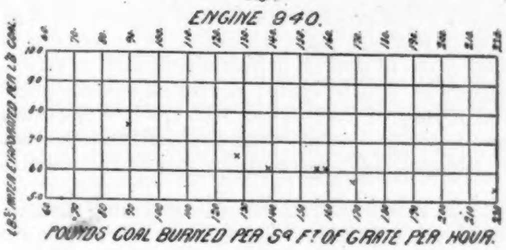


Fig. 4

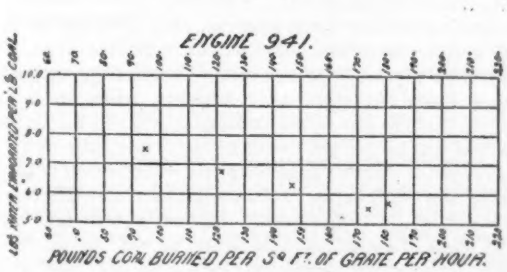


Fig. 5

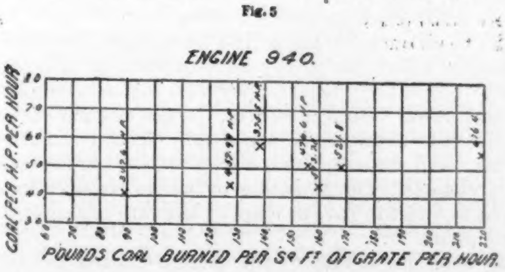


Fig. 6

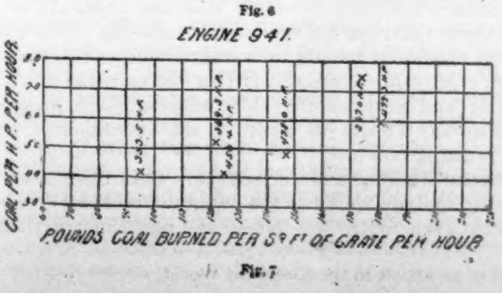


Fig. 7

that the particular heater tested was of no measurable advantage, or in other words, it did not actually heat the water appreciably. Some other design might show different results.

In the tests on exhaust pipes for the Master Mechanics Association upwards of 490 test runs were made, each necessitating 46 separate observations, making a total of nearly 23,000 observations. Of this number there were 367 complete recorded tests, comprising 16,882 separate observations. The others were run while adjusting the apparatus or else they wese defective in some particular and were therefore discarded.

The effect of different amounts of lead on the economy and smoothness of operation was tested on engine No. 901, a 19 by 24-inch eight-wheel engine, carrying a steam pressure of 190 pounds. This engine has 20-inch ports and Allen valves, and it was found that improved results were obtained by reducing the lead from $\frac{1}{4}$ inch to $\frac{5}{32}$-inch at 6-inch point of cut-off, while no worse performance as far as power is concerned was shown with $\frac{1}{8}$-inch lead at 6-inch cut-off with much smoother working. If the eccentrics are both set so as to give $\frac{5}{32}$-inch lead at 6-inch cut-off, the full gear lead with the length of eccentric rod used is nearly $\frac{3}{32}$-inch negative. That is, the valves at full stroke are blind by this amount. Careful tests indicate that the engine is more powerful in starting with valves blind to this extent than with a lead at full stroke up to $\frac{1}{16}$ inch. It seems probable, however, that about $\frac{1}{8}$-inch negative lead at full stroke, and $\frac{5}{32}$-inch positive lead at 6-inch cut-off is the best adjustment of the valves for fast passenger service with the valve gear as arranged on this engine.

Even with as stiff a valve gear as was used on engine 901, and it is above the average in this respect, the effect of deficient valve lubrication is very marked. Cards No. 9 and No. 10 were taken without changing anything about the engine except the lubrication of the valves, and they are by no means unusual examples. Without changing anything about the engine except the lubrication, the horse-power of the right cylinder was made to show the same as the other.

A rather complete set of 13 efficiency tests was next made on two 15 by 24-inch engines, Nos. 940 and 941, having 61-inch driving-wheels, 15.7 square feet of grate area and 1,125 square feet of heating surface. These engines are exactly alike in design and construction, and yet one was reported and actually showed results on the performance sheet from month to month which were much inferior to those of the other. The tests were undertaken primarily to discover the defect in the inferior engine and remedy it. The indicator cards from these engines were as nearly identical as possible, and when both engines were tested under the sams conditions their efficiency was found to be the same. The "inferior" engine, however, could with difficulty be made to steam as freely as the other on account of slightly defective front end adjustments. This was remedied, and on a test under service conditions on the road both engines did, as nearly as possible, identical work.

Incidentally while these tests were in progress the effect upon the evaporation efficiency of the boiler of varying the rate of combustion per square foot of grate was determined. In these tests no change whatever was made in the size of the grate, but the work done and consequently the water evaporated was gradually increased until rates of combustion varying from 90 pounds of coal to 180 pounds per square foot of grate area per hour were obtained in both engines, and as high as 219 pounds per square foot of grate per hour in engine No. 940. These results are shown plotted in Figs. 4 and 5. They confirm as well as could be expected under the different conditions the results obtained by Prof. W. F. M. Goss and presented at the September, 1896, meeting of the New York Railroad Club. These curves show a rapid and fairly uniform decrease in efficiency as the rate of combustion is increased. The decrease appears to be not at as rapid a rate after that of 150 pounds per square foot of grate is reached, but to establish the correctness of this indication more data should be obtained. These tests show the results obtained from engine No. 797 in tests above referred to, to confirm the results obtained with the deep box for a shallow firebox boiler. The results of the boiler evaporation at different rates of combustion are shown for engines 19, 567 and 797 respectively in Figs. 1, 2 and 3. The results from both engines Nos. 19 and 567, Figs. 1 and 2, are not as accurate and reliable as those in Figs. 3, 4 and 5 recording results obtained from engines Nos. 797 and 941. The error in the first tests was due to the water used being gaged in a tank of which the cross-section was obtained by calculation. In the tests of engines Nos. 797, 940 and 941 the exact weight of water was taken. The effect upon the total economy of the engine of different rates of combustion is shown by Figs. 5 and 6 giving the coal per horse-power per hour at rates of combustion covered by these tests.

The horse-power developed in each test is marked in figures on the diagram. Comparison of these results with those of the boiler performance only Figs. 4 and 5 is interesting. The abnormally high points on the diagrams are due to a leaky condition of the firebox in those tests.

Analyses of the smokebox gases while these tests were in progress resulted as follows:

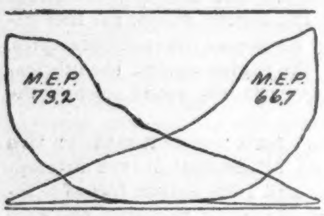
ENGINE NO. 940.

Number of miles per hour.	Length of cut off, inches.	Carbon dioxide, per cent.	Oxygen, per cent.
25	4½	11.1	6.
35	4½	10.8	5.8
45	4½	10.06	8.04
25	7½	11.8	5.4
15	10	10.	7.4

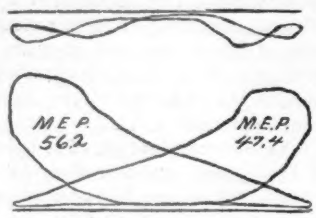
ENGINE NO. 941.

25	4½	9.03	9.43
35	4½	11.08	6.24
15	10	13.47	2.01

The series of tests above described on engines Nos. 940 and 941 were also utilized to give some data on the effect of long pipe connections for indicators. This subject was exceedingly well presented by Professor Goss at the St. Louis meeting of the American Society of Mechanical Engineers in 1896. The writer confesses that the importance of this matter for lengths of pipe no longer than ordinarily used on locomotives, say three or four feet, was not realized by him until the cards shown herewith were taken, and he wishes to expressly state that all the data based on indicator cards contained in this paper are subject to correction due to pipes 3 feet 8 inches long. Professor Goss has pointed out that it is practically impossible to establish general corrections for long indicator pipes on account of the number of different conditions which modify their effect. It may be possible, however, to establish certain limits of error for known speeds and cut-offs in locomotive cylinders and for the length of indicator pipes usually used which would meet all practical requirements. It is hoped that this important work may soon be undertaken. Cards taken by the same indicator, arranged so that one card was taken through an indicator pipe 3 feet 8 inches long, the other being taken from a pipe about 4 inches long, show the effect of the pipe at various speeds and cut-offs from 82 revolutions to 352 revolutions, and 6-inch and 9-inch cut-off, always to be to increase the area of the card from ⅓ to 16.9 per cent.



CARD No. 9
Valves well lubricated.



CARD No. 10
Deficient Lubrication.

Left Cylinder.........6 inches cut off.
Steam pressure.....................190.
Revolutions per minute..........168.
Miles per hour......................37.5
Horse-power.........................795.
589.

Difference in horse-power....206.

Right Cylinder.......6 inches cut off.
Steam pressure.....................190.
Revolutions per minute..........168.
Miles per hour......................37.5
Horse-power.........................589.

Effect of deficient lubrication of valves, Class "A," engine No. 901. Chicago & Northwestern Railway, Sept. 7, 1895.

An interesting series of tests of the tightness of cylinder packing rings was made on engine No. 567. The front steam port of one cylinder was plugged with a steam-tight plug, the front cylinder head was removed and the engine was run at various speeds under full throttle with cast-iron ring packing rings made with different joints, and also with the joint in different parts of the cylinder. The leakage was carefully observed for each condition and recorded. Briefly, the results indicated that the form of the joint was immaterial as long as it was kept near the bottom of the cylinder. The rings when free tend to rotate, sometimes one way, sometimes another, until they find their best bearing, then they seem to remain stationary. When rings are worn to fit cylinder and joints at or near bottom there is no leak with either lap or open joint. New rings put in cylinders only slightly worn leak until they are worn to a bearing. There was no more leakage at speed than when running slowly. The conclusions drawn from the test were that rings should not be free to turn and the joints should always be near the bottom and about 3 to 4 inches apart.

Tests of the efficiencies of two two-cylinder and one four-cylinder compound engines all of different design are now in progress, but still uncompleted.

Fuel Energy Into Electrical Energy.*

BY ELIHU THOMSON.

Notwithstanding the fact that in these days of long-distance transmissions at high voltages the energy of large water-powers will become more available, and also in spite of the fact that the fuel cost constitutes, in many cases, not more than 12 to 15 per cent. of the total cost attending electric distribution from stations, the problem of how to obtain an increased efficiency or a greater percentage of the potential work of a fuel as electric energy, loses none of its interest.

It is certain that if in obtaining any increase of yield the outlay for additional plant, or for more costly plant, or for maintenance and attendance, is such as to give rise to an increased charge of but a moderate percentage over the present costs, there would be a neutralization of benefits. Despite, then, the interest which the working out of any problem naturally has for the scientist and engineer, it remains a fact that any new plan or proposal for increasing the percentage of fuel energy rendered available, must, to be commercial, accomplish its results within such limits of cost and outlay as will depend on the cost of fuel in the particular locality where the plant is to operate.

By the use of triple-compound condensing engines at full load one horse-power hour may be developed at an expenditure of fuel of less than 1⅓ pounds of coal, a figure which is so low that in any locality where coal can be had for less than $5 per ton places the actual coal cost for full load conditions on a favorable basis as compared with other outlays in the working of an electric plant.

Indeed, the question of uneven loads and peaks in the load becomes then one of far greater commercial importance than saving of fuel alone, when the plant is working at its best, for the great waste of fuel comes in putting boilers into and out of service, while a large engine but lightly loaded is itself a wasteful piece of machinery. Any plan of fuel saving which, while providing for a given output is not flexible, or which does not lend itself easily to a system of storage, might have all its value neutralized in consequence.

Much has been said from time to time concerning the advantages of gas or oil engines as prime movers, and it is certain that their efficiency of conversion may easily rise to 20 per cent. of the energy value of the gas or oil supplied.

Even in quite moderate-sized engines, such as those of 30 horse-power and under, one brake horse-power hour has been produced for less than three-quarters of a pound of anthracite coal made into gas by one or other of the producer methods, while in oil engines of the gas engine type the oil consumption is, even for quite small engines, about one pound per brake horse-power hour.

There is reason to believe that with the work which is being done in improving the engines and producing gas under the most economical conditions, with fair-sized engines, power may be generated on the basis of about one-half pound of coal or oil per brake horse-power, or possibly somewhat better in the case of the oil owing to its relatively high calorific value.

There can be no question about the advantages which such fuel engines have in not requiring any consumption of fuel until they are started. Similarly, when stopped, fuel consumption stops. For a given horse-power cutout, however, the gas engines are probably more expensive as to first cost, while they require attention from time to time, as in cleaning, etc., which is not the case ordinarily with steam engines. The attention to boilers required in a steam plant might be offset in part at least by the care of a gas-producing and storing plant.

The many attempts to employ the thermo-electric principle rely upon an indirect conversion, but in this case there are no moving parts and the mechanical energy stage is missing. The heating of junctions of dissimilar metals in a thermo-electric series and the production of currents of electricity thereby seems at first the ideal of simplicity and practicability, but unfortunately, despite many most noteworthy efforts to improve the thermo-electric pile, its efficiency remains very low.

It is doubtful whether a better economy than 1 per cent. of the energy of the fuel, delivered to the outside circuit of the pile, can be attained even with the latest and best constructions. The

*Abstract of an article in the Electrical World.

actual construction and working of the piles themselves as well as their permanency have undergone great improvement in recent years, but there remains the fact that of the total heat conducted from the hot to the cold junctions, but a very small percentage is converted, or convertible perhaps, into electric energy. The pyro-electric generator of Edison would naturally be open to the same serious objection of insignificant yield.

The remaining type of apparatus for effecting the conversion in question is that in which the fuel or carbon is dissolved as is the zinc in a battery cell, while air or some other oxidizing agent acts as a deplorizer.

Many years ago Jablochkoff devised a hot battery in which nitrate of potassium or niter was fused in an iron pot which was made one pole or terminal, and a carbon stick dipped into the fused niter was the other pole. Violent reaction occurred due to the oxygen of the niter attacking in its hot state the carbon piece, while a fitful current of small energy value relatively to the activity of chemical reaction going on was noticed to flow in a circuit from the pot to the carbon.

Recently the battery of Dr. Jacques has commanded considerable attention. It would seem that in this battery there is in fact an actual quiet consumption of carbon without real combustion. The bath of melted sodium hydrate contained in an iron cylinder has bubbles of air passed up through it from which oxygen is taken up. The carbon rod immersed in the soda bath is gradually oxidized and a current obtained which leaves the carbon in the bath to go to the iron containing vessel and through an outside circuit from the iron to the carbon. It is claimed that as high as 85 per cent. of the energy represented by the solid carbon is thus converted into electrical energy available for use. There are of course difficulties, and perhaps the chief one is the carbonating of the sodium hydrate. Unless a bath can be found which does not form carbonate, and which therefore permits the free escape of carbonic acid gas, this difficulty might indeed be fatal. The handling of fused alkalies is not as easy as might be desired, and the renewal of carbons in battery cells is of course an objection, while the contacts to be provided for large currents passing from cell to cell through hundreds of cells appear indeed formidable. The Jacques battery also will require specially pure fuel molded carbons so as to be of proper form and a good conductor of electricity.

In view of all this the Central Station Manager need not, for the present at least, fear having to throw aside his boilers and engines. The smoothing out of the hills and hollows in the load diagram is apparently of more real importance in his case than systems which would double or treble the present coal efficiency, by which is meant the percentage of energy value of the fuel converted into electric current energy.

Operating Belleville Boilers on British Cruisers.

In an editorial on the excellent trials of the new British cruisers *Powerful* and *Terrible*, the *Engineer* gives the following interesting description of the methods employed in the fire-room, where 48 Belleville water-tube boilers furnish the steam, which suggests that much auxiliary apparatus and skilled labor are required:

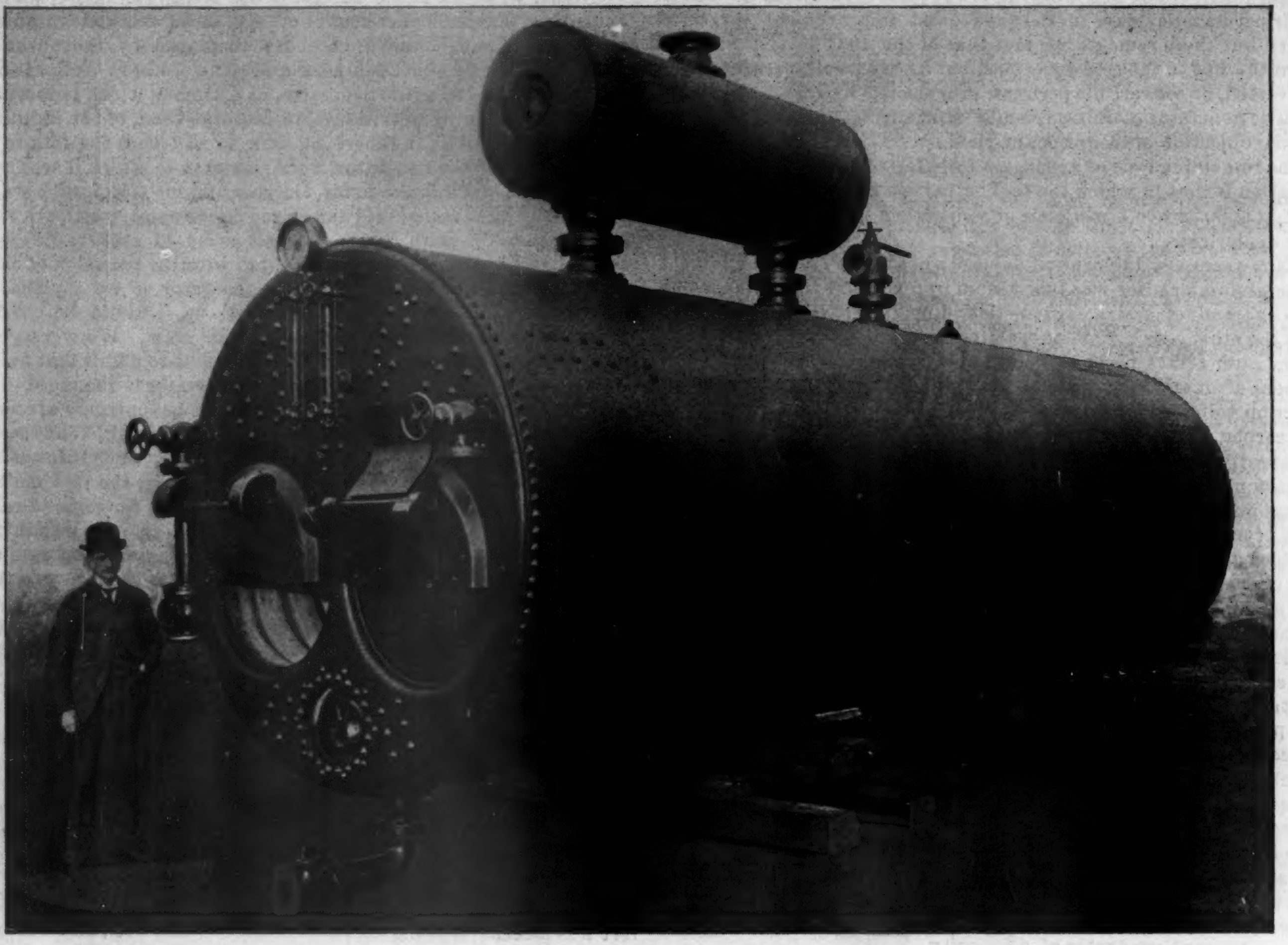
"Instead of the rough-and-ready way with which most of us are familiar, steam was made on these ships with a scientific refinement of manipulation the like of which has probably never been seen before. The Belleville steam generator is not, in the proper sense of the word, a 'boiler' at all. It is a very peculiar and special piece of apparatus; none the worse for that, however. But it must be treated in a special way, and its peculiarities must be thoroughly understood. It has been said by a very competent authority that it has no circulation in the ordinary sense of the word, and that is, we think, true; but it has certainly an efficient substitute for circulation. Again, in most boilers it has been found sufficient to admit air, or blow it in, above the fire to keep down smoke, but something more than this is needed with the Belleville generator; and so we find a number of cunningly devised air compressors, dispersed in the boiler-rooms, which supply divers small jets, and so throw streams of air into corners and out-of-the-way places among the tubes, and so there is flame produced where, without these jets, there would be smoke and a heavy deposit of soot. Furthermore, as the Belleville boiler will by no means tolerate bad stoking, a special system of firing has been devised. In each fire-room is a clock with a peculiar dial, and by its aid fires are fed with the regularity of machinery, and with a discrimination which no machine can pretend to manifest. Like everything else, the feed pumps have been specially designed, and the regulation of the feed is all but entirely automatic.

"When we speak of the success of the Belleville boiler, we must remember that the boiler could not have been worked to advantage, if at all, but for the skill and care displayed by those who had been intelligently educated in its use. The ordinary boiler is compared with the Belleville generator, as a kitchen clock is to a chronometer. When we hear, as we do now and then, of the failure of such boilers, it will, in future be safe to say that the failure has been due not to the generator, but to the way in which it was used. The greatest credit is due to Mr. Durston and his staff for the way in which they have recognized and seized on the point which are vital, and for the skill with which a small army of stokers has been trained to do exactly what was wanted with the precision of clockwork. It is no disparagement to the generator if we say that we do not think that outside her Majesty's Navy, it would be possible to find so splendidly disciplined a fire-room crew. We venture to think that Mr. Durston will be among the first to admit that everything depends on the way in which the generator is managed—in a word, on the way in which the details of the new process of steam-making are carried out; and we not unnaturally ask, What would happen if the exigencies of warfare should leave such ships as the *Terrible* with a crew of stokers quite untrained in the new method of steam making? We have no doubt but that for some years to come the Belleville generator will have it all its own way in the Navy. We trust it will not be introduced faster than men are trained in its use; and, indeed, it seems to us to be desirable that the two new ships should be kept in commission for no other purpose than to pass stokers through them as training ships. We believe that fixed boilers on land are intended to be used for this purpose."

A Test of Petroleum Fuel.

In a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* particulars are given on some experiments with oil firing for boilers made by Messrs. Weyler & Richmond. The first experiments were made on a boiler apparently of a modified Cornish type which formed one of a pair. Its fellow was fired by coal, and served as a means of comparison. Each of these boilers had 393 square feet of heating surface, of which 226 feet was internal heating surface, furnace tubes, etc., and the remainder external. The capacity of each was 157 cubic feet, of which 122 cubic feet were water space. The oil used was a heavy American oil, having a specific gravity of .910. On its way to the burner it passed through a water jacket, in which its temperature wass raised to 100 degrees or 120 degrees Fahr. The burner was arranged to spray the oil by means of a jet of slightly superheated steam from the second boiler. The spray thus produced formed a large flame on issuing from the burner, and was deflected by a special shield so as to throw it down on to the grate, which for the purpose of the experiments was, with the rest of the furnace, lined with firebrick. Through the portion covering the grate there were air openings, which were inclined upward and away from the jet. The number and size of these openings were varied several times before the best results were obtained. The first observations were directed towards ascertaining the time required to raise steam. The best time made was 1¼ hours, the comparative slowness being attributed to the large amount of heat absorbed by the furnace lining. The best evaporative efficiency was 12.6 pounds of steam, evaporated at a pressure of 85 pounds per pound of fuel employed, equivalent to about 13 pounds of steam from and at 212 degrees Fahr. It was found that about 400 cubic feet of air were required per pound of oil burnt, and that the orifices in the grate should be proportioned so as to give this air a velocity through them of from 15 feet to 21 feet per second. Further experiments on a small semi-portable engine generating 10 horse-power and working at a pressure of 98 pounds per square inch, showed a consumption of 3.94 pounds of oil per horse-power per hour.—*Engineering*.

President Fish, of the Illinois Central Railroad, is said to have proposed a plan for government control of the Pacific railroads, which contemplates the taking by the Government of both the Union and Central Pacific roads, and making of them a public highway from the Missouri to the Pacific, giving all connecting roads equal rights thereon. This could be accomplished either by the Government's maintaining the roadbed and letting every company run its own trains over it or by having government engines to haul all cars that may be offered. It is probable, however, that the Union Pacific will be sold to a satisfactory private bidder.



A Lancashire Boiler with Welded Shell.—Built by the Continental Iron Works.

A Large Lancashire Boiler With Welded Shell—Built by the Continental Iron Works.

The Continental Iron Works, of Brooklyn, N. Y., are well known for the excellence of their boiler work, their ability to turn out flanged plates of the most difficult forms, and for the welded steel shells made by them for various purposes. This welded work is almost essential in the construction of pulp digesters for paper mills, as the changes in temperature to which the digesters are exposed, together with the searching qualities of the soda charges put in them, make it almost impossible to keep riveted joints tight for any length of time. The company has made pulp digesters of various sizes, the largest of which is 7 feet in diameter and 29 feet long. There is not a single riveted joint in these structures, the heads being welded in and the manhole flanges being also welded to the shell.

The corrugated furnaces for marine and land boilers form another class of work in which welding takes the place of riveted joints, and of which the output of this company is very large.

The company has recently turned out a fine piece of work in the shape of a large Lancashire boiler with a welded shell. The boiler, a view of which we give in the accompanying illustration, is 8 feet 6 inches in diameter and 27 feet 3 inches long, and has the largest welded shell that has ever been made in this country, and it is believed to be larger than any built in any other country. The photograph shows it to be a beautiful piece of boiler work.

The boiler is to be set up in Lynchburg, Va. It will carry a working pressure of 125 pounds, and has been tested at 180 pounds. The shell is $\frac{9}{16}$ inches thick and the heads are $\frac{3}{4}$ inches. The furnaces are of the Morison suspension (corrugated) type and are 40 inches in diameter. They extend from end to end of the shell, the appearance of the back end resembling the front one, except for the absence of the fittings. The furnace doors are the Morison patent, secured to pressed steel furnace fronts. These fronts are protected on the inside by perforated cast-iron liners. The Morison door is arranged to open upward, and is counterweighted so as to remain open while the furnace is being stoked. Thus latches and similar devices are avoided. It also is of such a form as to prevent accumulation of fuel on the front end of the grate, and thus prevents the overheating and ultimate destruction of the door and its attachments, besides keeping the boiler-room cooler and making it more comfortable for the men. This fire-door has been adopted by many prominent firms for both marine and land work, and by the United States Navy.

The manhole plates, rings and crabs are of pressed steel, and of the most approved form.

The company's boiler work has been largely for marine purposes, but it is now making internal furnace tubular boilers which possess many advantages, among which are their great economy, the absence of a brick setting, and the ease with which they can be kept clean. These boilers are cylindrical, with corrugated furnaces, and tubes for returning the gases to the uptake at the front end. Several large plants are wholly equipped with boilers of this kind.

It is said that in a few weeks the Bazin roller-boat, which was launched some time ago, will be ready for trials at sea.

"The 4 p. m. Limited" between Boston and New York on the Boston and Albany Railroad has been newly equipped with elegant coaches and drawing-room cars, built by the Pullman Company expressly for this train. All the cars are vestibuled, and it is claimed they excel, in beauty of finish and comfort, any others in New England. A dining-car is attached to the train between Boston and Springfield. Like all passenger trains on this road, the cars are lighted by gas and heated by steam.

Communications.

The Training Which Apprentices Need.

ATHENS, Pa., Feb. 6, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In an article under this head in the January number of your journal, the foreman was severely censured for the unsatisfactory working of the present apprentice system. Now let us look at the material we have to work with. The boys are employed around depots and railroad shops because they are cheaper than men and they are taken as young as the law will allow. As an inducement for boys to take such jobs as wiping, errand boys, call boys and the like, they are offered an opportunity to learn a trade. As a rule, the boys that accept these positions are insubordinate; they have either been expelled or will not go to school. Their parents prefer they would loaf around an office or do anything rather than to loaf around the streets.

Now the first thing they learn is to loaf, and when they commence their apprenticeship they must learn to loaf on scientific principles and watch the boss or superintendent. They must have something handy to scrape or hammer when he is around. You can see by this that the foreman has the worst material the town affords to begin with; cheap labor is the first and last object of the companies.

Suppose the applicant for an apprenticeship is required to graduate at the high school or show some good reason for not doing so; some are obliged to get work to support a mother or themselves, but these boys are upright and of good moral character. This class of boys would not be desirable. They would not accept a job of wiping at 40 or 60 cents per day for six months or so for the privilege of serving four years at a trade.

The companies would be obliged to pay from one dollar to one and a quarter for men to do the work that the boys are doing at present, but they would have a better class of apprentices—a class that the foreman would feel some encouragement in teaching and by whom it would be appreciated. The night schools would flourish, the boys would have the rudiments of a technical education, and you could make better workmen of them, for the workmen have degenerated with the apprentices.

In a shop of over 400 men and boys I do not know of one who reads a technical paper of any kind. At present it is impossible for a young man who has graduated to get a situation to learn a trade, for every place is filled a year ahead.

Gentlemen of the Master Mechanics' Association and the Railroads, give us better material, and we will show you what we can do.

A GRADUATE.

Our correspondent is undoubtedly right in urging the selection of better material for apprentices. It is almost impossible to cover all points in discussing a matter of such magnitude as the requirements of a good apprentice system, and in the editorial referred to in this letter we had assumed for the moment that apprentices for whom a technical training such as proposed by the Master Mechanics' committee and others, were of such a character as to profit more or less by such training. The knowledge which such young men seek when they enter the shop is not to be found in a technical education, but in what is commonly known as shop training. This they seldom get as fully as they might, sometimes through the fault of the foremen, but more frequently because of the lack of interest in them by the heads of departments, and the failure to make provision for their proper instruction. We had no intention of dealing severely with the foremen, as they are not responsible for the present condition of affairs, but it is well for them to bear in mind that the part they must play will be a most important one in any successful plan to give apprentices a better training than they now receive.—ED.

Air Compression by a Falling Column of Water.

NEW YORK, Feb. 10, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In the current issue of your paper you notice a method of air compression adopted at an installation near Montreal, Can., and refer to it as being a "novel" manner of compressing air. On the ground of belief that most persons might, at first sight, think such a system an entirely new one (judging from your adjective "novel") and feeling that you commendably wish your journal to be a star of the first magnitude in the heaven of exactness, I presume far enough to hint that the use of a column of falling water is by no means new as applied to air compression. If I mistake not, such a plan was in use for blowing air in the very early days of iron working processes under the name of the "Trompe" blower and in numberless laboratories is the principle used with an opposite object in view, *i. e.*, attenuation instead of compression, to expedite filtering operations. An illustrated article on this form of compressor, by G. D. Hiscox, Consulting Engineer, was published in Engineering Record, for Nov. 19, 1892. See also an allusion to it by W. F. Durfee, M. E., in Trans. A. S. M. E., Vol. VII., pp. 804-805. I I have such an arrangement in use in my home for supplying, when wanted, a continuous current of air, operated by a form of injector which I made for the purpose, as I had not the advantage of a column of water.

Of course, I may be all wrong in my understanding of your meaning of the word "novel." If you mean by it "not old" then the foregoing holds good; if "not usual" then I silently back down.

Very respectfully yours,

WM. F. MONAGHAN,
Member A. S. M. E.

[Perhaps it would have been better either to have avoided the use of the word "novel" or to have been less brief and to have explained our use of the word. We were aware of the earlier use of the same method of compressing air mentioned by our correspondent, and in using the word "novel" in our description of the Taylor plant had in mind the fact that it was "not usual," and furthermore that the earlier applications of the method were not made, if our information is correct, with a view of obtaining the high pressures such as obtained in the case cited. It was employed more as a blower, rather than a compressor, as those terms are understood to-day. We trust this explanation will clear away the fog that appears to envelop our allusion to the Taylor compressor.—ED.]

Superheated-Steam Engine Trials.

At a meeting of the Institution of Civil Engineers, in January Prof. Wm. Ripper read a paper on the above subject, and presented in tabulated form the results of many engine trials in which superheated steam was used.

The author pointed out that the limit of possible economies from multiple expansion and high-pressures having been nearly reached renewed attention was being given to superheating. Trials have been carried out on a 17 indicated horse-power Schmidt motor, a single-acting, simple, non-condensing engine, supplied with superheated steam from a Schmidt superheater, to determine the steam consumption of the engine working with various degrees of superheat, and at temperatures beyond those usually employed; and also to find to what extent the dryness fraction of the steam, and the heat exchange between it and the cylinder walls, were affected by the superheat.

The heat expended in superheating reduced the amount of heat employed in evaporation of water; but the heat so diverted for the purpose of superheating was shown to be productive of a considerable gain in thermal efficiency. Thus an expenditure of 5, 10 and 15 per cent. of the furnace heat to superheat gave a net gain of 12, 38 and 70 per cent. respectively of the work done for heat supplied. When the load on the engine was fairly constant, little regulation of the superheat was necessary, and the temperature of the superheated steam in the coils remained remarkably steady. If the load on the engine was reduced, the temperature of the steam in the superheater immediately began to fall, though there was no appreciable change in the condition of the fire; on the other hand, if the load was increased, the temperature of superheat increased also.

The effect of varying degrees of superheat upon the steam consumption per unit of power was illustrated by a large number of trials under varying conditions. Taking one example, it was shown that steam at 120 pounds per square inch pressure superheated to 674 degrees Fahr. on entering engine, reduced the steam consumption from 38.5 pounds without superheat, to 17.05 pounds per indicated horse-power per hour, the rate of decrease of steam consumption with increase of superheat being approximately uniform within certain limits.

It was pointed out from the indicator diagrams how rapidly the superheat disappeared on the admission of the steam to the cylin-

der, and how few were the cases in which the steam in the cylinder was found to be superheated at cut-off, though admitted in a highly superheated condition. It appeared from these experiments that unless the degree of superheat of the steam entering the engine reached at least 200 degrees Fahr. above its normal temperature with a late cut-off, or a still higher degree of superheat for an earlier cut-off, the condition of the steam in the cylinder at cut-off was that of wet steam at the temperature of saturation.

In order that the steam in the cylinder might be superheated during expansion and dry at release, it was necessary that its temperature on entering the engine should be about 300 degrees Fahr. above the temperature normal to its pressure. When the steam was dry at release it was superheated at cut-off from 50 degrees Fahr. to 100 degrees Fahr., finally falling at end of about three expansions to the temperature of saturated steam. For a small increase in the number of expansions the temperature at cut-off rapidly fell to that of saturated steam.

The author considered superheating not as a means of obtaining a thermal efficiency in any way proportional to the temperatures used, but as a device for realizing as far as possible the full thermal efficiency of saturated steam by rendering the cylinder practically non-conducting. The practical difficulties supposed to be associated with the production and use of superheated steam had been satisfactorily overcome. Experience had shown that with ordinary care as to purity of feed water, superheater tubes after long periods of severe work showed no signs of burning, scalding, or injury of any kind. With the greatly improved quality of lubricating oils no trouble need arise with the lubrication of superheated steam engines.

The best results could be obtained when the steam was supplied at about 650 degrees Fahr. at the engine. It was important to use good non-conducting material to maintain the high temperature of the steam in its passage to the engine. The best results in these trials had been obtained in association with a high range of pressure in one cylinder with a late cut-off. Any cause which tended to increase initial condensation in the cylinder with saturated steam tended also, with superheated steam, to absorb the superheat and to neutralize its useful effect in the cylinder. Superheated steam at high temperatures might be safely and advantageously used in double-acting engines. Many such engines were now at work or in course of construction.

The point requiring chief consideration in the design of engines to work with superheated steam was the steam-admission arrangements. The steam-admission valve, being subjected to the maximum temperature, should be practically frictionless, so as to remove the necessity for its lubrication.

Richmond Notes.

THE RICHMOND LOCOMOTIVE WORKS.

A visit to Richmond last month and a call at the Richmond Locomotive Works found this firm in that condition of almost complete idleness which is at present common to all of the locomotive builders of this country who have no foreign orders on their books. At the Richmond works, however, there was the promise of renewed activity; for a few days before the writer called they received one order for 10 locomotives, and another for six boilers, and these, with still another order taken some time ago for summer delivery and some miscellaneous work, while not making a rushing business, gives an improved prospect for the immediate future.

A season of idleness is not the best time to visit a shop, but a short walk through this one impresses the visitor with the fact that for years past the policy of the management has been to purchase the best of machine tools, and to buy a good many of them. The machine shop contains many fine modern tools from the best-known and most reliable builders. Milling machines are extensively used, and without exception they are heavy and substantial tools. It is found that milling is, generally speaking, much cheaper and better than planing. The saving comes from two sources—the smaller number of hours required for a given piece of work, and the fact that lower-priced men can be employed on milling machines. Other modern tools installed in these shops might be mentioned, but there is not much to be said about them individually, except that they are right up to date.

All the work in the machine shop is conducted on the piece-work plan, and with satisfaction to all concerned.

The buildings were not originally built for locomotive work and their low roofs make it impossible to use traveling cranes, except over the erecting floor, where a 15-ton rope-driven crane has been in use for years. The engines of to-day are so heavy that the need of a heavier crane is felt. The conditions which make it impossible to use traveling cranes serving the entire floor of the machine shops have been met by air hoists, many of which travel on trolleys and serve several machines each. As in other shops the advantages of compressed air are fully realized.

In the past year a 350-horse power Greene engine has been installed to furnish power for most of the plant. The engine is a fine one, and has been so placed in the engine-room as to permit of being made into a tandem compound at a later date if desired. The machine and boiler shops are so located as to make it comparatively easy to drive the machinery in them both from one engine, and when certain changes and enlargements now in progress are completed, the carpenter and pattern shops will also be supplied with power from this same engine. The machine shop has two parallel lines of shafting, and clutches near the driving pulleys make it possible to cut out either shaft and run the other alone—as in the case of a breakdown or the running of one o two large tools at night. The shafting in the boiler shop is operated by a rope drive, and a similar clutch makes it possible to run or shut down this department independently of the others.

In the boiler shop hydraulic riveters are used on the boiler work and pneumatic riveters are confined to tank work. A fine set of bending rolls driven by a small double steam engine is noticeable in the equipment of this department.

The blacksmith shop and the foundry are at present in opposite ends of the same building, but a new smith shop, 100 feet by 260 feet, has been built and is ready to be occupied. It is a frame structure, is high and well lighted. The boilers and heating furnaces are to be placed along one side of the shop, entirely outside of the building proper, but right up to the building line of that side. The roof has an overhang on that side to give shelter to them. A track on a trestle just outside of the building permits coal to be delivered by hopper cars directly to the boiler and furnace-room floors without any manual labor. When the smith shop is moved into this building the area of the foundry floor will be extended and the remainder of the present smith shop devoted to carpenter and pattern work.

These notes would not be complete without acknowledging the courteous reception given to us by Mr. Jones, Secretary of the Company; Mr. Delaney, General Superintendent, and Mr. Speirs, in charge of the boiler shop.

THE CHESAPEAKE & OHIO SHOPS.

The shops of the Chesapeake & Ohio Railroad, at Richmond, have received a recent addition in the shape of an excellent paint shop. The building is 165 feet long inside, and about 66 feet wide, the three tracks holding two cars each, or six cars altogether. The length of the tracks is sufficient for two of the longest of Pullmans. The building is excellently lighted from large windows in the walls, from the monitor in the roof and from large lights in the slope of the roof.

The roof is carried on iron trusses. The floor is concrete, perfectly drained, and altogether the building is admirably adapted to its purpose. An annex along one side of it provides storage for the paints, oils and other supplies. The only criticism that might be made is the apparent lack of adequate room for the varnishing of blinds, sashes and interior fittings.

This road lights its through passenger trains by electricity, the current being supplied entirely by Silvey storage batteries. Two plants for charging the batteries are maintained, one at Covington, Ky., and the other at Richmond. The Covington plant takes care of the cars on the Western end of the line and the trains in the Cincinnati-New York service, while at Richmond, the batteries on the cars on the Eastern end of the line are kept up. The batteries are arranged in groups of six cells, there being a total of 12 cells per coach. These 12 weigh about 1,400 pounds and will supply current for a round trip from Cincinnati to Jersey City and return, and then have a reserve of 22 hours' lighting. The batteries have a life of 17 to 18 months and cost $15 per cell complete. At the end of the 18 months the entire battery does not

need replacement, for the jar at least can be used again and the negative plates have a much greater life than the positive plates, sometimes outlasting three sets of the latter. The arrangements for handling the batteries are very complete, but they have been described several times in various journals and are doubtless familiar to our readers.

We were fortunate enough when visiting the shops recently to see a new air-brake instruction car just before it started out on its initial trip. It is about the size of a passenger coach and resembles one in outside appearance. At one end is an upright boiler with a coal bunker and water tank adjacent to it. On each side of the middle portion of the car the air brake apparatus is arranged. This consists of an engine equipment, one tender brake, one passenger equipment and 16 freight brakes. There are the usual valves in sections to illustrate their construction and operation, and a complete outfit of signal apparatus. At the other end of the car is a neat office, with a desk on it and on one side a long seat that can be made up into two berths. The toilet arrangements are complete and in all respects the car is a model one.

Several cars in local service were being equipped with a device for preventing the tipping of truck frames with the application of the brakes. The device consists of spring roller bearings secured to the floor framing with the rolls bearing on a plate or shelf secured to the end pieces of the truck frames. When the brakes are in the released position the springs in the bearings force the rolls down on to the truck end frames and the bearings are free to yield to the motion of the truck, but when the brakes are applied, connections from the brake levers key the bearings solid, so that the springs in them are inoperative. Then the truck frames cannot tip, but must remain level. The device has not yet been put into service, but it would appear to be open to the objection of transmitting unpleasant shocks and vibrations from the trucks to the car body and thus to the passengers.

We noticed in the boiler-room a hydraulic pump that is a great labor-saving arrangement for testing boilers. It consists of the steam cylinder of a 6-inch air-brake pump with a 1¾-inch hydraulic cylinder in place of the air cylinder. The pump is bolted to the wall and a pressure gage near by records the water pressure obtained. From the pump water pipes are run into that part of the shop where boilers are tested, and when a boiler is filled with water, connections are made and the engineer notified to start up the pump and maintain a certain desired pressure. Thus the old portable hand pump is dispensed with and the labor of pumping by hand avoided.

Compressed air is used in the shops to a considerable extent, and will be used more when funds are available for the purchase of air compressors. At present the air is compressed by one Pedrick & Ayer belted compressor, and the limit of its capacity has been reached. Among other uses the air is employed to press in rod bushings, and driving-box brasses. A press with a 20-inch cylinder is used. The press is also employed to force out old rod bushings, and in doing this work it was found that after the bushing once started it left the rod with a rapidity and force that was startling if not dangerous. To correct this, the foreman, Mr. Gould, put an oil cylinder on top of the air cylinder and attached the piston in the upper cylinder to that of the lower one. A port in the upper piston permits the oil to slowly pass from one end of the cylinder to the other, thus acting as a dash pot and regulating the speed of the air piston.

Mr. Sanford Keeler has been appointed to represent the Nathan Manufacturing Company in Chicago. He is a well-known railway man, having filled several important positions in the Northwest, and takes charge March 1.

The Baltimore & Ohio and B. & O. Southwestern railways are running fast freight trains between New York and St. Louis, the eastbound train being scheduled at 80 hours from St. Louis to New York, 75 hours to Philadelphia and 70 hours to Baltimore. The westbound time is even faster, being 60 hours from New York, 55 from Philadelphia and 50 from Baltimore. Arrangements have been made by the B. & O. S. W. to load cars at St. Louis direct for the Eastern cities.

The Etrusion Process for Forming Metals.

In an article on the manufacture of metallic alloys, Industries and Iron describes the process employed at the works of the Delta Metal Company in England. The Delta alloys are of various compositions, some of them being improved bronzes, while others are based upon the introduction and chemical combination of definite quantities of iron to which they owe their great strength and toughness. Some idea of the extent to which this metal is worked after casting may be gained from the equipment of the smithshop which contains two large steam hammers, a gas hammer, several olivers, a hydraulic press, a large bolt machine, two drop stamps, etc. Delta metal forges at a lower temperature and more readily than wrought iron. But what we intended to quote from the article was the reference to the etrusion machine in use at these works.

"An account of the machine was recently given in a paper before the Iron and Steel Institute. Its principle consists in forcing the metal, heated to a plastic condition, through a die, by means of a hydraulic ram. The machine is admirably adapted not only for round, square and hexagon bars, wire, angles, etc., but also for all descriptions of sections of complex design, even those which it would be impossible to roll. The molten metal is either poured into the container and allowed to cool, or it is introduced in the shape of a cast billet, which is previously heated in a furnace. The container is then turned into into a horizontal position, and the metal forced through a die held by powerful hydraulic clips in the crosshead. Numerous difficulties were naturally experienced in perfecting the process, one of the chief being the construction of the container, which has not only to withstand the high temperature of the contained metal, but likewise while under the influence of that temperature has to meet the severe strain brought upon the interior. The difficulty was overcome by constructing the container of a series of concentric steel tubes alternating with annular spaces packed with a dense non-conducting material whereby the inner liner exposed to the high temperature is reinforced by the surrounding cold steel tubes.

"The machine produces about 40 charges from one to two hundred weight each per day, and is served by two men and a lad; consequently a great saving in labor is effected, compared with rolling mills, while the hydraulic press is actuated by pumps requiring only about 15 horse-power, which is another great advantage over rolling mills. The orders for bars of all kinds of sections having increased very much, a new and more powerful machine is now being erected in spacious premises adjoining those already described. Not only bars, etc., of Delta metal are produced by this patent extrusion machine, but also of common brass, naval brass, manganese and aluminum bronze, etc.

"The diversity of objects for which it can be utilized is accentuated when the fact is mentioned that nearly 300 separate dies have already been manufactured for the machine now in use. Rods and flats varing from ⅛ inch up to 3¾ inches are produced with the greatest of ease and rapidity, and are of a quality much superior to those produced in the regular way, while the machine effects a saving of somewhere about 75 per cent. in cost of production.

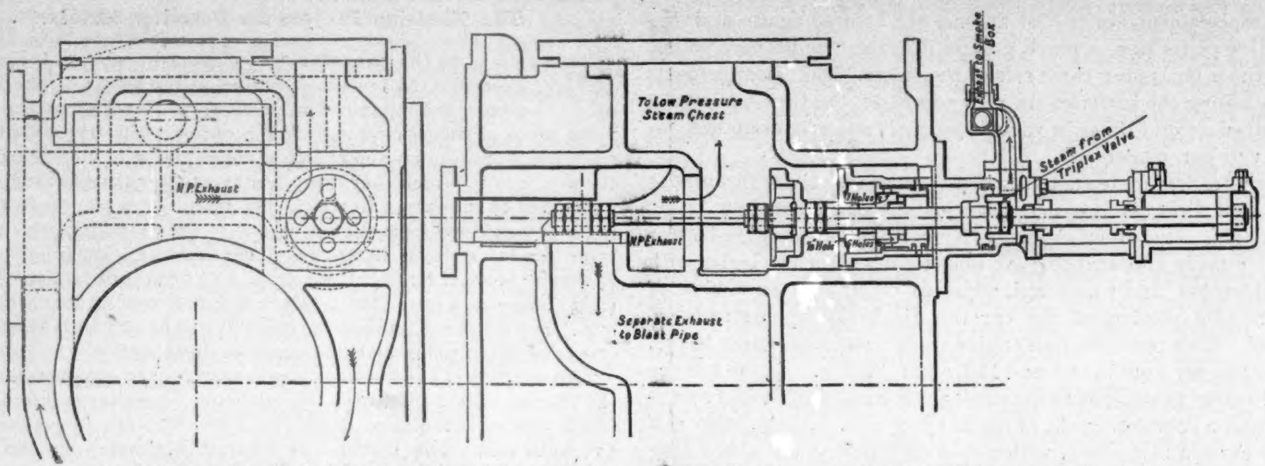
"On account of the high pressure employed in their production, extruded or pressed bars possess increased tensile strength and greater toughness. For bars of Delta No. 1 alloy, for instance, tested at the Royal Arsenal, 48 tons per square inch with 32 per cent. elongation against 38 tons per square inch and 20 per cent. elongation of rolled bars and yellow metal bars, showed an increase in tensile strength of 24 per cent., with a proportionate increase in elongation over rolled bars.

"Aluminium is treated most successfully by this process."

Intercepting Valve for Compound Locomotives on the Great Southern and Western Railway, Ireland.

We reproduce herewith from the Engineer an intercepting valve used on compound locomotives on the Great Southern and Western Railway in Ireland. It was designed by Mr. Ivatt, then Locomotive Superintendent of the road, and now with the Great Northern Railway.

"The engine is built under the Wordsdell von Borries and Lapage's patents. This valve allows the engine to be worked 'simple' or 'compound' at will. It is actuated by a small lever and rod from the footplate, which, by suitable valves, admits steam to a cylinder on the spindle of the change valve, and so moves it to either position, the movement being controlled by a dashpot. When in the 'simple' position the valve opens a communication from the high-pressure exhaust to the blast pipe, round the underside



Intercepting Valve for Compound Locomotives.—Great Southern & Western Railway, Ireland.

of the high-pressure cylinder; at the same time it closes the communication from the high-pressure exhaust to the low-pressure steam chest, and opens a connection for live steam from the steam pipe to the low-pressure steam chest. This supply of live steam is wiredrawn so as not to exceed about 75 pounds pressure on the low-pressure side, and low-pressure cylinder and steam chest are, as usual, provided with relief valves, set to blow at 75 pounds in case the pressure should exceed that amount.

"In ordinary working the engine is always run compound, and starts without any trouble, but for starting on an incline, or for getting away quickly with a heavy train, the arrangement for working simple is of great advantage, and enables the engine to exert as much power as a simple engine with two 18 inch cylinders and the same steam pressure. The arrangement is also exceedingly handy for shunting; there is no steam locked up in the receiver, and the engine does not, in steam-shed phraseology, 'beat two or three times after steam is shut off.'

"The working of the change valve is entirely in the hands of the driver. Mr. Ivatt does not believe in the theory that it is not advisable to give the driver the power of working simple if required. To argue that the driver of a compound engine so fitted is likely to work the engine simple any longer than is absolutely necessary, is about the same as saying that the driver of an ordinary engine cannot be trusted to pull the reversing gear up as soon as possible."

Steam and Electric Railway Grade Crossings.

The twenty-eighth annual report of the Massachusetts Railway Commission, relating to street railways, has an interesting chapter on grade crossings between steam roads and street railways. It begins by stating that "Since the electric car began to take the place of the horse car, attention has been called from time to time to the greater risk of casualty at grade crossings of street railways with railroads. We have felt more strongly the difficulties as well as the responsibilities of dealing with this matter since the passage of the Act of 1895, Chapter 426, which requires the consent either of this board or of a special commission to the creation of new crossings of this kind. So far, all of the applications for such consent have been made to this board. We regard it as our duty to carry out the policy intended by the legislature, and it is largely in this view that we again call attention to the subject."

The report then takes up the "Broad Cove collision" in the town of Somerset, where a New York, New Haven & Hartford pessenger train collided with an electric car, smashing the latter to splinters, and derailing and overturning the locomotive and tender, and derailing the combination car. Nobody was killed and the board feels that because of that fortunate circumstance the people of the State have not drawn from the accident the lesson they should. The accident occurred in a blinding snowstorm and the electric car had not started to cross the tracks until the conductor had gone ahead and signaled that all was clear. The board thinks the collision justifies two inferences as follows:

First. The dangers at the grade crossings of electric railways with railroads are in reality more than have been taken into account. It has been commonly assumed that the railroad train, with its ponderous locomotive, would brush aside the electric car without seriously endangering its own passengers, as it usually does other highway vehicles; and it has sometimes been intimated that if the electric railway was willing to take the risk, the railroad had little occasion to concern itself. The life of the railroad passenger is of no more value than that of the electric railway passenger; but it is clearly shown by the recent case that both are likely to be involved in the same catastrophe.

Second. It is apparent that the risks at such crossings are too great, and the present provision for the security of life too small, as regards both the railway and the railroad.

"Several remedies may be suggested. (1.) The plainest remedy is the separation of the grades of the railroad and highway. There is now sufficient provision of law for doing this, except that the railway company has no power to initiate proceedings. Such power may properly be given, the railway company bearing a fair proportion of the cost.

"(2.) Where the abolition of the highway grade crossing is for any reason impracticable, the route of the electric railway may often be deflected so as to pass over or under the railroad, outside the limits of the highway. The objection is frequently encountered that the railway company can acquire land for this purpose only by purchase, and if at all, only at the owner's price. The right to take land in such case, under regulations and limitations similar, perhaps, to those which now apply in case of land required for improving the alignment of a railroad, might well be given to the railway company. Such legislation seems to us highly desirable. This remedy would not infrequently remove the prime necessity for abolishing the highway grade crossing.

"(3.) Some audible signal operated by the railroad train, such that it begins to ring when the train is 1,500 or 2,000 feet away, and continues to ring until the train has passed the crossing, might in many cases afford protection to the crossing. It is assumed that in the present stage of electrical development some automatic signal of this kind may be found which can be depended on to work reliably.

"(4.) The more effectual and sure method of protecting the crossing would be by an interlocking apparatus, similar in principle to that in use at grade crossings of railroads with each other. As applied to the crossing of a railroad with an electric railway, the former should doubtless have as a rule the right of way, with derails, if any, only on the latter. This system of protection is required in the State of Ohio as regards all new crossings, and may be prescribed as regards all crossings; and we are informed that the law of Illinois is similar."

The Hardie Compressed Air Locomotive for the Manhattan Elevated Railway.

In about a month one of the most important trials of compressed air ever made for traction purposes will begin on the Sixth Avenue line of the Manhattan Elevated Railway in this city. All the machinery for these trials has been built, and the work of installation is proceeding rapidly. The Hardie compressed air motor which is to haul the trains has been completed at Rome, N. Y., and will be sent to this city as soon as the air compressing plant is complete. Through the courtesy of the American Air Power Company, 160 Broadway, New York, who are supplying this motor for trial, we reproduce herewith two photographs of it taken at different stages of its construction. As shown in its more complete state it still lacks headlights, handrails and other small fittings that will add to its general appearance.

This motor carries within the cylindrical shell that takes the place of the boiler of a steam locomotive 36 Mannesman rolled steel tubes 9 inches in diameter. Thirty of these are 15 feet 6 inches long, while the lower six of the group are 21 feet 3 inches long and extend under the floor of the cab, almost to the buffer plate. The total capacity of these flasks is about 200 cubic feet.

The Hardie Compressed Air Locomotive.

Air will be stored in them at 2,000 pounds pressure per square inch. From these reservoirs the air goes at a reduced pressure of 150 pounds to a vertical re-heater placed in the cab. This re-heater resembles a vertical boiler in appearance and is about 30 inches in diameter. It will be charged with water at a temperature of about 350 degrees Fahr. and can be maintained at that temperature by a small fire under it. The air as it comes from the reservoirs is very dry and of normal temperature. As it passes through the water it not only receives heat but also takes up moisture until the dew point is reached. Experiments with a similar motor, which has operated very successfully for nearly eight months on the street railways in New York City, shows that on the average the amount of moisture taken up is .0188 pounds of water per cubic foot of free air. From the re-heater the air goes directly to the working cylinders. These are 13 inches in diameter by 20 inches stroke.

In designing this locomotive the American Air Power Company were compelled by circumstances to follow quite closely the proportions of the steam locomotives on the road. The total length of the engine from bumper to bumper had to be the same as the present engines, viz., 23 feet 9⅜ inches, so that all stop signals at the stations would be right for this motor. The limit of weight of the present steam locomotives is 47,000 pounds, and this figure had to be met in the new motor, and furthermore that weight had tobe carried on the same total wheel base, so as not to overtax the elevated structure. The driving wheel base is 6 feet, and the total wheel base is 16 feet 1 inch. The drivers are 42 inches indiameter. With the exception that the cylinders are placed under the cab, the details of the running gear are somewhat similar to those of the steam locomotives on the road, but they have been designed throughout for a pressure of 200 pounds per inch, and a speed of 50 miles per hour. To accomplish this and come within the specified weight very careful designing was necessary. It will be noticed in one of the views given herewith that the driving axles and crank pins are hollow.

It is our purpose to illustrate this engine in detail later on, and we will therefore reserve further description until that time. The power station to supply the compressed air is as interesting as the locomotive itself.

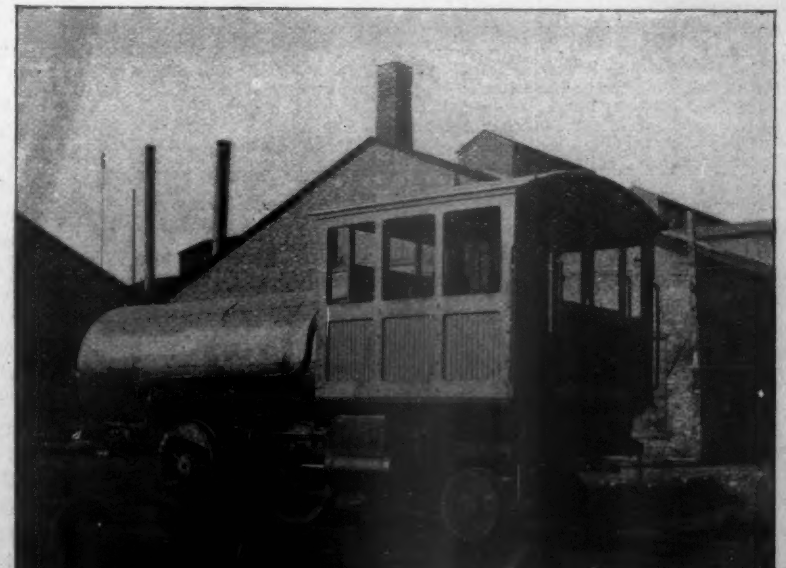
It is located at 98 and 100 Greenwich street, and a four-stage compressor built by the Ingersoll-Sergeant Drill Company is already in position.

This compressor has two 18-inch by 36 inch Corliss steam cylinders and placed tandem with them are four single-acting air cylinders, two to each steam cylinder.

These air cylinders are 21½, 9, 7 and 3 inches in diameter, by 36 inches stroke.

One begins to realize what compression to 2,500 pounds means when he looks into a 21½ by 36-inch cylinder and realizes that its volume of air is packed into one end of a 3-inch cylinder before the desired pressure is attained. Of course, the air passes through inter-coolers between each two stages of compression, and it is also cooled immediately after leaving the last cylinder. This compressor will deliver the air at a pressure of 2,500 pounds per square inch into a large nest of Mannesman tubes, similar to those on the locomotive. There are to be 144 tubes all nine inches in diameter, most of them 15 feet 6 inches long, and a few of them 21 feet 3 inches long. The air is thus stored at a pressure 500 pounds in excess of the storage pressure on the locomotive, so that when the latter is charged the storage volume and pressure are sufficient without drawing directly upon the compressor.

One cannot but be impressed with the thoroughness with which the plans have been worked out and the preparations made for an extensive trial of this system of traction, and the performance of the plant will be awaited with interest.



The Hardie Compressed Air Locomotive.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

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Secretary Herbert, on Feb. 17, signed an order abolishing the Naval Steel Board, and transferring its work to the bureaus of steam engineering and construction. In so doing, he has rid the navy of a board that for 12 years has been a source of constant trouble, and has assigned the work performed by the board to parties more capable of giving it intelligent supervision.

The attempt to form an association of round-house and railway machine shop foremen, which we understand is being made, is worthy of encouragement from the superior officers of these men. It is natural to conclude somewhat hastily that we already have too many railway associations, but while there is something to be said on this point there is also much to be said in favor of this particular movement. Nothing so stimulates the mental activities as to get away from the details of one's business for a few days and see and hear what others in the same line of work are doing. This being true, the fewer opportunities a certain class of men have to get away from their work, the greater we would expect the benefits to be of association and organization among them. This seems to be the situation among the foremen, and it appears to us that the proposed association would prove beneficial to the men themselves, and through them to the companies they serve.

It is stated that the flattering results of tests of a Parsons steam turbine for marine propulsion, recorded in these pages last month, has led the British Admiralty to seriously consider giving it a trial in a number of launches and torpedo-boats in the British Navy. The turbine would appear to be well adapted for such work, for with its high speed, it gives large power without involving great weights, and, as we know, this desirable feature is obtained without a sacrifice of economy. The propelling machinery of the boat, whose preliminary trials we mentioned last month, consists of three shafts, each driven by a steam turbine, and each having three propellers, the second being of coarser pitch than the first, and the third being coarser still. Thus there are nine propellers in all, and they run at the high rate of 2,400 revolutions per minute. In the preliminary trials, a speed of 29.6 knots was obtained, the boat being only 100 feet long and 42 tons' measurement. By a change in the pitch of the propellers it is expected that over 30 knots will be obtained. Steam is supplied by one water-tube boiler.

It is somewhat singular that with the intense interest manifested in compound locomotives for some years past in this country—an interest that seemingly allowed few details to escape study—the question of the ratio between the cylinder volumes, should not have been the subject of experimental work. The proper ratio for locomotive work cannot be derived from experience in stationary or marine work, for the reason that the working conditions are so different, particularly the wide range of cut-off employed on the locomotive. The practices of railroad companies and builders have varied greatly, the ratios at present ranging from three to one to a little more than two to one. The testing plant of the Chicago & Northwestern Railway is expected to soon furnish data on this important subject. In making certain alterations on a two-cylinder locomotive the question of cylinder ratios came up, and, in view of the lack of definite information on the subject, it was decided to make some experiments, particularly as various ratios between two and three to one could easily be obtained by bushing the high-pressure cylinder of the locomotive in question. The result should afford a valuable contribution to available knowledge on the proportions of compound locomotives.

Perhaps no better example can be found of the manner in which poor inventors are deluded into entertaining extravagant hopes of rewards for inventions than is given by the stories circulated about the "Sleepy Eye" rotary engine. The engine as illustrated in the patent papers has two characteristics, the first of which is that it will not run at all, except it be from the impact of inflowing steam, rather than by its direct pressure, in which case the power produced would be infinitesimal compared with the steam used; the second characteristic is that the engine is reversible. The patent shows a construction that must be classed with the worst rather than with the best of rotary engine designs. There is nothing new about it, and several years ago we saw in Chicago a rotary with the same reversing valve, also arranged with considerable ingenuity to provide for using the steam expansively. How the "Sleepy Eye" engine patent papers could go through the hands of an honest and capable attorney and a conscientious patent examiner without being criticised for being without novelty we leave our readers to explain to their own satisfaction. And yet the story of how this patent has been sold to an English syndicate for from $1,000,000 to $7,100,000 spot cash has been circulated around the entire globe. One of the greatest sinners concerned in circulating this story is a contemporary interested in patents and patent soliciting, who prints the story of the sale and gives without comment of its own the information that the inventor has already received a check for an enormous sum. The patent is a poor protection to a poorer design and reliable journals would be better employed in exposing the worthlessness of such so-called inventions than in circulating doubtful stories of fabulous profits reaped by incapable inventors.

COMPRESSED AIR AND ELECTRIC TRACTION IN NEW YORK.

Recent developments would seem to indicate that in New York City electric traction will soon have an opportunity to achieve wonderful successes, while in the same city it must also meet and vanquish, if it can, its at present vigorous competitor, compressed air traction. Just as we go to press officials of the Manhattan Elevated Railway announce that General Manager Fransioli, after personally investigating the operation of the electrically equipped elevated roads in Chicago, has so strongly endorsed electric traction in a report to the Executive Committee of the Board of Directors that it has been decided to give the same system a trial on the Manhattan lines, and that a beginning will be made on the Second avenue line. At the same time the Metropolitan Company is preparing to equip its Sixth and Eighth avenue surface lines with an electric conduit system similar to that used for some time on the Lenox avenue line. Thus electricity has evidently the opportunity to add two more triumphs to its long list of successful applications to heavy city traffic.

But compressed air is going to have its day too. The Hardie air locomotive will in about a month be in operation on the Sixth avenue line of the Manhattan Elevated Railway, and the same type of motor has for months been in service on the 125th street service line. The Metropolitan is also to give a different form of compressed air motor a trial on its lines, so that in both surface and elevated traffic compressed air will have a chance to show what it can do. It is not exaggeration to say that these compressed air trials will be watched with great interest by those concerned in urban and interurban traffic. We are informed that there is a constant stream of visitors from all parts of the country to see the air motor on the 125th street line and that the interest taken in it is phenomenal. Notwithstanding all that is said to the contrary, the desire is general for a motor that is not at all times dependent upon the power-house, and if compressed air and the brains and capital enlisted in its development can furnish such a motor, one that is commercial and financially a success, a hearty welcome will be accorded it.

BALANCED SLIDE VALVES.

An English contemporary, noted for its chronic distrust of all things American, recently undertakes to discuss balanced slide valves, and the need of them on English engines. It begins with a disclaimer of all intention of vouching for the truth of the statement—contained in a report to the Master Mechanics' Association last year—that 15,000 locomotives in this country are fitted with Richardson balanced valves. Probably it has not occurred to our contemporary that its voucher is not needed and that the report alluded to will be credited as truth everywhere except in its own editorial sanctum. However, having relieved itself of all responsibility in connection with this statement, it enters into the subject from an English standpoint, and comes to the very sensible conclusion that with the larger valves now common there it becomes desirable to take up anew the question of balancing.

In English practice it has been uncommon to use balanced valves because they have not been a success. One reason for this appears to be the use of cylindrical rings, which have almost invariably proved a failure, though there is an improved form of this type of balance now in use in this country for which good results are claimed. The four straight strips forming a rectangular enclosure on top of the valve hold the record for reliability in this country. The early forms of cylindrical rings used in England appear to have given so much trouble from sticking that the balance plate under the steam-chest cover has been placed at a slight angle to the valve seat instead of parallel to it, so as to give the rings some motion and prevent sticking. One surprising objection urged against the balanced valves is that "unless some form of relief-valve is fitted to the cylinders, a locomotive with a balanced valve will, when running down an incline, draw in cinders from the smokebox through the exhaust." A little reflection ought to show any one that a balanced valve has no monopoly on the cinder-drawing business, and that air valves—which are held to be a complication—are good things to have on any engine that must occasionally run with steam shut off. Our contemporary suggests such a simple (?) way of getting rid of those complicated relief valves: It would so connect the cylinder cocks with the throttle that the closing of the latter would open the cocks, but while steam was on the cocks could be opened by the engineer. We would estimate the probable diameter of cylinder cocks doing duty as air valves at not less than 2 inches on a passenger engine, and have a vision of a cylinder cock rigging extended up to the throttle, and made about 10 times as strong as the present construction in order to open the large valves under pressure, and can imagine the exasperating experiences of the engineer who tries to get water out of the cylinders, and finds that all the steam goes too. Delightful is it not? Why should not our English contemporary own up that the present American practice in balanced slide valves and relief valves is all right? It is not an acknowledgment of greater ability on the part of Americans; conditions here simply compelled to solve the problem before the need of a solution was felt in England.

THE RAILWAY PROFESSION AND A TRAINING THEREFOR.

At the January meeting of the New York Railroad an interesting topic was brought up for discussion by a paper on "The Profession of the Railway, and a Suggested Course of Training Therefor." It is a subject that many railroad men are thinking about, if we can judge by the readiness with which they entered into the discussion. We would hardly expect to hear a dissenting voice in a discussion on the need of special training or the advantage of special education for those who are to be entrusted by railroad companies with great responsibilities. But when we come to consider how that education shall be obtained and of what it shall consist there is every opportunity for a divergence of opinion.

After listening to the discussion at the meeting referred to, we felt that at the outset the term railway profession needed a definition as different speakers seemed to have different ideas in mind when using the term. Possibly it would be best for us to leave the definition to those who originated the term, but if we consider for the moment that proficiency in the railway profession embraces all those qualities which are needful to the intelligent and successful management of railway properties, it is evident at once that the field covered by the railway profession is a large one. Furthermore, a study of the lives of those who have been most successful in this field seems to teach us that the groundwork for that profession is not confined to any one course of business or technical education. Some of the most capable men at or near the heads of our great corporations have started as civil engineers; others have made their beginning in the traffic or operating departments, while a few have made their first great successes in the mechanical department. Few of these men are well grounded in *all* these branches of railroad operation and management, and yet they are successful in the higher positions to which they have been called. In the special education for the railway profession, what shall be emphasized—engineering, operation, finance or law?

Without necessarily differing from those who are pleading for the special education, we would like to make a suggestion. If the great business of transportation is such a factor in the engineering, business, commercial, financial and social worlds, why should it not receive its proper share of attention in the regular courses of studies in our colleges and technical schools? That it has not been so recognized is evident upon reflection. We have our engineering schools and colleges, for instance, and in them a student can study and test stationary engines, steam turbines, gas engines, electric motors, etc., but there is only one University in the whole world (Purdue) that has considered steam engineering as applied to locomotive practice to be of sufficient importance to warrant it in spending money for a locomotive testing plant as a part of its laboratory. And so we might go through all the other professions or sciences that touch the great business of railroading or transportation in general, and we will find that in them also railroading has been pushed aside or lightly toucheed upon in our

colleges and universities. Those responsible for this condition of affairs owe the railroad fraternity an apology for their neglect.

If the railway profession is accorded its proper place in the curriculum of our universities, several advantages will accrue; first, the public will be gradually educated on a subject that is of importance to it, even if every student does not engage in the business actively, and ultimately this public will be more just to the railroads; second, the young men destined to engage in railroad work, but who would not be likely to take up the special course can in a measure be fitted for their future duties; and, third, such a course would not in the least interfere with a special training, such as has been suggested.

STEEL CAR FRAMES.

We would call attention to an article on the repairs of French cars which appears elsewhere in this issue. The interest at present taken in steel cars in this country warrants us in giving considerable space to this subject. While it is true that French construction and French practice in general will not strictly apply to the conditions in this country, there is much to be learned from their experience. The method of conducting repairs and their expense, the results of collisions in distorting steel frames, and many other similar matters are subjects on which railroad men feel the need of enlightenment before they do much with steel cars. This knowledge cannot be obtained to any great extent from experience in this country and must be sought for abroad.

The article alluded to is so complete that we would only take the space to emphasize a few points. It will be noticed that the most satisfactory car is one in which the sections composing the frame are made heavy. We know it is possible to get a strong steel frame that is lighter than a wooden one, but care should be exercised to have no very light sections used in its construction or corrosion and deterioration will weaken it rapidly. The aim should be to have heavy sections, even if they are made fewer in number.

Then in the matter of repairs it is found that it pays to keep steel parts in stock to replace damaged parts, thus keeping the car out of service the minimum of time, and straightening or otherwise repairing the damaged parts at leisure (if they can be repaired) and putting them in stock for use on other cars. The cost of repairs is by this method found to be lessened. This immediately suggests that if steel underframes are to come into general use in this country it is of great importance that we get down to standard dimensions. And there is no reason why we should not. The task will not be easy, but the results will pay for all the labor expended in this direction.

The heavy repairs will, in all probability, have to be done at a few leading points, but it is not be anticipated that the inconvenience of so doing will be great. The more the repairs to steel cars can be concentrated the less they will cost.

One of the most striking facts brought out in the article mentioned is the ultimate saving from the longer life of the steel frames. Though their first cost is greater, their lesser repairs make their total cost at the end of a few years no greater than wooden frames and after that time the showing in favor of the steel cars increases rapidly, as will be shown on a full page diagram next month. We believe that notwithstanding it deals with French cars the article will be of value to those interested in steel cars in America.

NOTES.

Our esteemed contemporary The Railroad Car Journal contemplates building—with the aid of various railway supply houses—a private car for the President of these United States. We know the government is poor and that it has to issue bonds to pay expenses, but we did not dream it was reduced to such straits as this.

Last month a special train on the C., B. & Q. R.R., consisting of an engine and one car, made a run from Chicago to Denver, 1,026 miles, in 18 hours and 52 minutes. It is probably the best long-distance run on record when we consider the mountainous country through which the train passed in the latter half of its journey. The average speed, including stops, was 54 miles per hour.

On some of the new freight engines built for the Baltimore & Ohio by the Pittsburg Locomotive Works the new Bell Spark Arrester, invented by Mr. J. Snowden Bell, has been applied. The new arrangement consists of a double perforated deflecting plate, and the disposition of the netting in a series of inclines, with no horizontal surface except a very narrow one on each side of the exhaust pipe. It is said that this arrangement not only prevents the escape of so many live sparks, but it preserves the life of the netting, and is, therefore, more economical and effective than any spark arrestor now in use on any other road.

An ingenious reflector for a water gage glass is illustrated by the *Engineer*. It is perforated just behind the glass with three vertical rows of holes about $\frac{3}{16}$ of an inch in diameter. These holes are seen without distortion through the part of the glass that is without water, but viewed through the water the three holes in each horizontal row appear elongated into one narrow slit. The distinction between the two parts of the tube is said to be very sharp. The reflector is coated with plain enamel or luminous paint as preferred. This same gage is enclosed in a tube of tough wired glass to prevent injury from the flying pieces of a broken water glass.

Torpedo boat, No. 6, built by the Herreshoffs at Bristol, R. I., made her official trial trip last month. The contract speed was $27\frac{1}{2}$ knots, but in five runs over a course of 12 nautical miles the average speed was 28.73 knots, notwithstanding that one of the blowers became deranged during the last 12 miles-spin, making that particular run much below the average. The highest speed for 12 miles was almost exactly 29 knots. These figures are, however, subject to small corrections when all the calculations of the Board are completed. In its preliminary report, the Board says: "At her great speed the vibration was very slight, even over the screws, and there was no evidence of that effort and strain ordinarily noticeable on full power trials. Only a very slight wave was produced."

The floor of the new electric light station in Paterson, N. J., is a novel one. According to Power, it consists in effect of a huge casting of concrete, forming an undivided floor for the whole station. It is 4 inches thick, but at intervals of 15 feet there are cast on the under side beams 18 inches deep and 9 inches wide, running crosswise of the station and resting upon supporting piers of brick. The floor is further stiffened by longitudinal ribs 14 inches deep and tapering from 6 to 4 inches in thickness, spaced about 4 feet centers and bridging the spaces between the heavier crosswise ribs. These ribs are a unit with the floor. The floor is said to have cost one-third less than a floor involving the use of iron beams. It presents a surface that is never slippery and that is easily kept clean.

The new twin-screw freight and passenger steamer *Pennsylvania*, of the Hamburg-American Line, was placed in commission Feb. 18 on the regular service between New York and Hamburg. She left New York on that date with a full cargo, carrying a total of over 18,500 tons measurement. This is the largest cargo that was ever taken out of New York on one ship, or for that matter the greatest that any ship in any part of the world carried. To form an idea of the enormous quantity which this amount of freight represents, it is interesting to note that it would take 616 ordinary freight cars, or about eighteen freight trains, to transport it. Among its miscellaneous cargo the Pennsylvania carries 294,069 bushels of grain, equaling 6,847 tons, which is in itself more than the average freight steamer can take, if completely filled.

A press dispatch from Washington, under date of Feb. 15, states that Mr. Lorimer, of Illinois, after conference with the Secretary of the Navy, introduced a bill in the House to authorize that official to make a twenty-year contract with the Illinois Steel Company to supply armor plate for ships at $200 per ton, which is $263 per ton less than the present price. Mr. Gates, the President of the Illinois Company, was in the city some days, and says that his associates will agree to put up a plant to cost $3,500,000 if the contract asked for is awarded them.

An interesting instance of an hydraulic accumulator being supplanted by that alert agent compressed air comes from New England. An hydraulic system was in use in a factory where many presses were employed on work which required the full pressure to be attained regularly and promptly. It often occurred that when the water pressure was rapidly turned on and off from a press the work would be spoiled because the full pressure was not realized. This lack of pressure was found to be due to the inertia of the accumulator—it could not move fast enough to maintain the pressure on the ram of a press during its entire stroke and it required a moment of time at the completion of the stroke to give the maximum pressure. To prevent the spoiling of work from this cause the accumulator was removed and a small Norwalk compressor was installed and employed to maintain the required pressure on the hydraulic system. It does its work satisfactorily and no matter how quickly the presses are operated the compressed air follows up the flow of water and keeps up the pressure.

The New York, New Haven & Hartford Railroad turned out of its New Haven shops about a month ago a coach sheathed with No. 30 sheet copper. The outside sheathing is the narrow kind so much used and each board has been separately covered with the copper before being put into place. The copper is lapped into the groove and around the tongue. The window panels, letter boards, etc., are all covered so as to be practically water proof. The entire exterior is covered with copper except the doors, window sashes, hoods, platforms and roof. Painting and varnishing in thus avoided. The copper was oxidized after being put in place, but it can be put on as it comes from the mills and allowed to oxidize by the action of the atmosphere. The advantages of the copper sheathing are no deterioration of the finish, time saved over painting and varnishing and ease of repair. It is claimed the cost is not greater than painting and varnishing. The weight of copper used was about 1,000 pounds, but the wood sheathing underneath was thinned sufficiently to keep the weight of the car the same as before. The metal sheathing is the idea of Mr. W. P. Appleyard, Master Car Builder.

Powerful Compound Locomotives for the Northern Pacific Railway.

In our issue of December, 1896, we mentioned the fact that the Schenectady Locomotive Works were building for the Northern Pacific Railway four Mastodon or 12-wheeled compound locomotives of great power. These engines we now illustrate in the full-page engraving on the next page.

The engines are the most powerful of this type ever built. They are two-cylinder compounds with high pressure cylinders, 23 inches in diameter by 30 inches stroke and low-pressure cylinders 34 inches in diameter by 30 inches stroke. The intercepting valve is of the new design gotten out by the Schenectady Locomotive Works, which enables an engine to be operated as a simple or compound engine at will.

The boiler is 72 inches in diameter at the front end. It is of the extended wagon-top style and for much of its length is of greater diameter than this figure. It is designed for a working pressure of 200 pounds per square inch, and this pressure, combined with its large diameter, called for very heavy construction. Consequently we find sheets from $\frac{9}{16}$ to ⅞ inch thick used for the shell. The material is carbon steel, as is also that of the firebox.

The grate is 120$\frac{3}{16}$ inches by 42 inches, and has an area of 35 square feet. The heating surface is greater in area than has ever been obtained before in locomotive practice, namely 2,943.4 square feet. The weight of the engine is 186,000 pounds, of which 150,000 pounds is on the drivers. We give herewith a complete specification of the engine:

General Dimensions.

Gage........4 feet 8½ inches
Fuel........Bituminous coal
Weight in working order........186,000 pounds
" on drivers........150,000 pounds
Wheel base, driving........15 feet 6 inches
" " rigid........15 feet 6 inches
" " total........26 feet 4 inches

Cylinders.

Diameter of cylinders......High pressure, 23 inches; low pressure, 34 inches
Stroke of piston........30 inches
Horizontal thickness of piston........4¾ inches and 5¾ inches
Diameter of piston rod........3¾ inches
Kind of piston packing........Cast-iron rings, sprung in
" " rod packing........Jerome metallic
Size of steam ports, high pressure, 20 inches by 2⅛ inches;
low pressure, 23 inches by 2⅛ inches
Size of exhaust ports, high pressure, 20 inches by 3 inches;
low pressure, 23 inches by 3 inches
Size of bridges ports........1⅝ inches

Valves.

Kind of slide valves........Allen-Richardson
Greatest travel of slide valves........6⅛ inches
Outside lap " "........1⅛ inches
Inside clearance " "........¼ inch
Kind of valve stem packing........Jerome metallic

Wheels, etc.

Diameter of driving wheels outside of tire........55 inches
Material " " " centers........American cast steel
Tire held by........Shrinkage
Driving box material.....Cast steel on main only, balance steeled cast iron
Diameter and length of driving journals, main...... 9 inches by 10 inches
" " " " " " all others, 8½ inches by 10 inches
" " " " main crank pin journals, side rod,
7 inches diameter by 5¼ inches; main, 6½ inches diameter by 6 inches
Diameter and length of side rod crank pin journals,
intermediate 5½ inches diameter by 5 inches; F. & B., 5 inches diameter by 3¾ inches
Engine truck, kind........4-wheel, swing bolster
" " journals........6 inches diameter by 11 inches
Diameter of engine truck wheels........28 inches
Kind " " " "........Steel tired, cast-iron spoke center

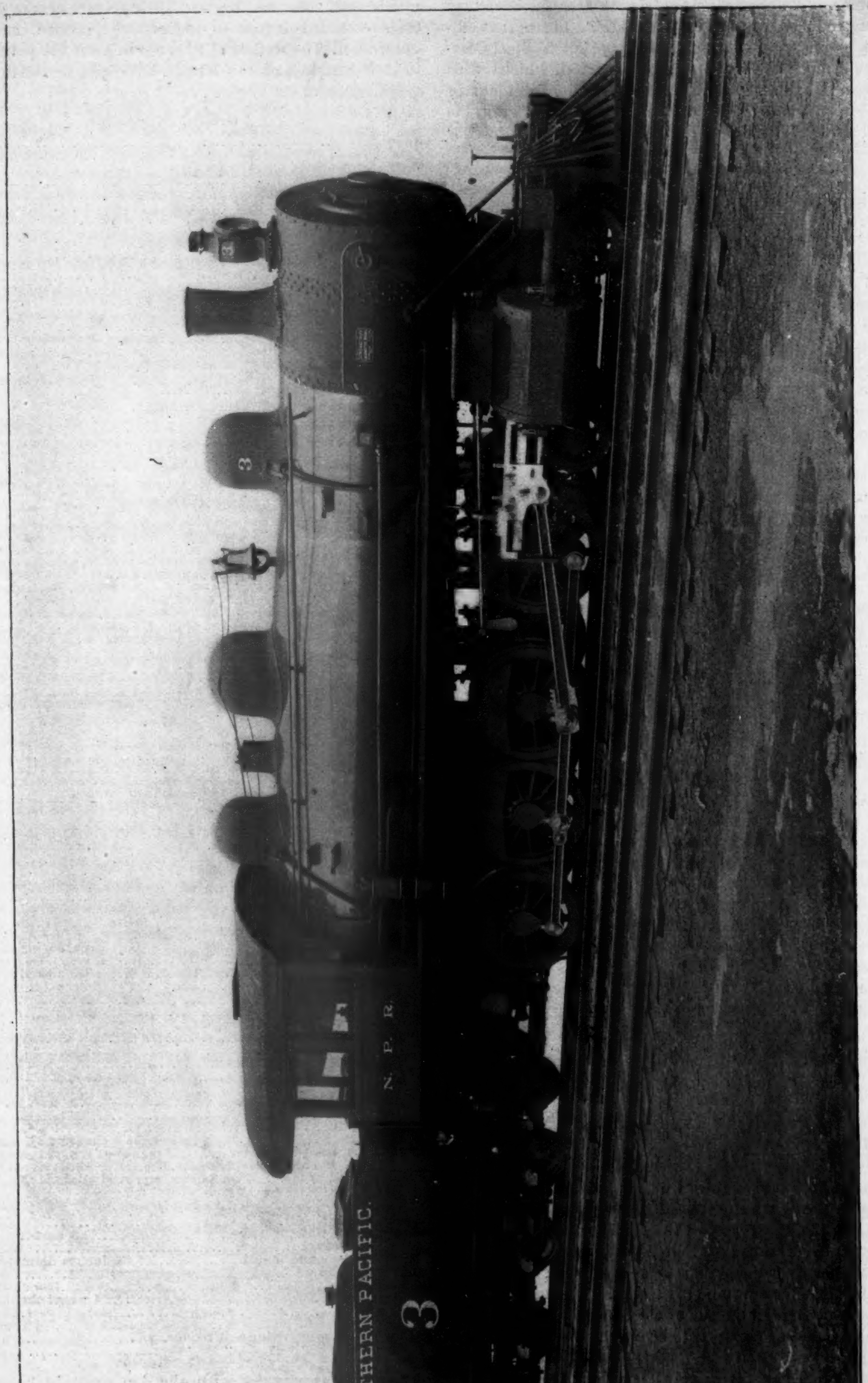
Boiler.

Style........Extended wagon top
Outside diameter of first ring........72 inches
Working pressure........200 pounds
Material of barrel and outside of firebox........Carbon steel
Thickness of plates in barrel and outside of firebox.
½, $\frac{11}{16}$, $\frac{13}{16}$, ⅞, ¾, ⅝ and $\frac{9}{16}$ inch
Horizontal seams,
butt joint, sextuple riveted, with welt strip inside and outside
Circumferential seams........Double riveted
Firebox, length........120$\frac{3}{16}$ inches
" width........42 inches
Firebox, depth........Front, 77 inches; back, 73⅛ inches
" material........Carbon steel
" plates, thickness........Sides, $\frac{5}{16}$ inch; back, $\frac{5}{16}$ inch;
crown, ⅜ inch; tube sheet, ½ inch
" water space. Front, 4½ inches; sides, 3½ inches to 4 inches;
back, 3½ inches to 4½ inches
" crown staying........Radial stays, 1⅛ inches diameter
" staybolts........Sligo iron, 1 inch diameter
Tubes, material........Charcoal iron, No. 12, W. G.
" number of........332
" diameter........2¼ inches
" length over tube sheets........14 feet 0 inches
Fire brick, supported on........Water tubes
Heating surface, tubes........2,721.6 square feet
" " water tubes........15.3 square feet
" " firebox........206.51 square feet
" " total........2,943.41 square feet
Grate surface........35. square feet
" style........Rocking
Exhaust pipes........Single
" nozzles........5¼ inches, 5½ inches and 5¾ inches diameter
Smoke stack, inside diameter........18 inches at top, 16 inches near bottom
" " top above rail........14 feet 10 inches
Boiler supplied by........Two Sellers improved Class M, No. 10½ injectors

Tender.

Weight, empty........36,300 pounds
Wheels, number of........8, cast-iron plate wheels
" diameter........33 inches
Journals, " and length........4½ inches diameter by 8 inches
Wheel base........15 feet 3 inches
Tender frame........10-inch steel channels
" trucks........4 wheel channel iron frame
Water capacity........4,000 U. S. gallons
Coal "........7½ (2,000-pound) tons
Total wheel base of engine and tender........53 feet 8 inches
" length " " " "........62 feet 1 inch

The engine is provided with the American brake operated by air on all drivers, the Le Chatelier water-brake on cylinders, the Westinghouse automatic air-brake on tender and for train, the Westinghouse air signal, three 3-inch Ashton safety valves, magnesia sectional covering on boiler, dome and cylinders, Dean's sand feeding device, Kewanee reversible brakebeams, and the McIntosh blow-off cock.



POWERFUL TWELVE-WHEELED COMPOUND LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY.

Built by the Schenectady Locomotive Works, Schenectady, N. Y.

Personals.

Mr. E. V. R. Thayer has been elected Vice-President of the Chicago & West Michigan Railway.

Mr. James E Worswick, Master Mechanic of the Georgia & Alabama at Americus, Ga., has resigned.

Mr. G. M. McIlvain has been appointed Receiver of the Sharpsville Railroad, with office at Sharpsville, Pa.

The Governor of Illinois has nominated for Railroad Commissioners Charles S. Rannells, C. J. Lindley and J. Bidwell.

Mr. H. F. Forrest has been appointed Manager of the Great Northwest Central, with headquarters at Brandon, Man.

Mr. Robert H. England has been appointed General Manager of the Oconee & Western, with headquarters at Empire, Ga.

Mr. William Aird has been appointed Acting Master Mechanic in charge of the Montreal shops of the Grand Trunk Railway.

Mr. M. G. Howe has resigned as General Manager of the Houston, East & West Texas, but will continue as Vice-President.

Mr. R. E. Smith, of the Atlantic Coast Line, has been appointed Superintendent of Motive Power, with office at Wilmington, N. C.

Mr. Dickerson MacAllister, Chief Engineer of the Metropolitan Elevated road of Chicago, was last month appointed Receiver for that road.

Mr. C. M. Ward, formerly General Manager of the South Carolina, has been appointed Receiver of the Greenwood, Anderson & Western.

Mr. H. R. Harris has been appointed General Manager of the Lake Superior & Ishpeming, with headquarters at Marquette, Mich.

Mr. John Boynes, for 31 years Superintendent of the passenger-car shops of the Pennsylvania at Altoona, died at Altoona on Tuesday last.

Mr. I. M. Schoomaker, formerly Vice-President, has been elected President of the Pittsburgh & Lake Erie, and J. P. Wilson, of Youngstown, becomes Vice-President.

Mr. J. W. Fitzgibbon has been appointed Assistant Superintendent of Motive Power and Equipment of the Chicago, Rock Island & Pacific, to succeed Mr. H. Monkhouse, resigned.

Mr. James Collinson was, on Jan. 20, appointed Superintendent of Motive Power and Machinery of the Gulf, Colorado and Santa Fe, to succeed Mr. George A. Hancock, recently resigned.

The Baldwin Locomotive Works are now represented in the West by Mr. William Rhodes, the Assistant Superintendent of the works. Mr. Rhodes' office is at 1217 Monadnock block, Chicago.

Col. George W. Dunn has been nominated by the Governor of New York as Railroad Commissioner to succeed Alfred C. Chapin, and Ashley W. Cole and Frank M. Baker have been renominated.

Mr. R. W. Moore has been appointed Division Master Mechanic of the Pittsburgh Division of the Baltimore & Ohio Railroad, with headquarters at Glenwood, Pittsburgh, vice Thomas Trezise, resigned.

Mr. J. A. Miller, Private Secretary to General Manager Ashley of the Ann Arbor Railroad, has been appointed purchasing agent of that road, to succeed Mr. Frank S. Chandler, resigned. Headquarters, Toledo, O.

Mr. N. S. Meldrum, formerly Secretary and Treasurer of the Houston, East and West Texas, has been appointed General Manager of that road, with headquarters at Houston, Tex., vice Mr. M. G. Howe, resigned.

Mr. C. F. Quincy, Treasurer of the Q & C Company, was elected Vice-President of the National Association of Manufacturers at the Philadelphia meeting. He represents the State of Illinois in the list of Vice-Presidents.

Chief Engineer William S. Smith, U. S. N., who has for three years past been stationed in Philadelphia as a member of the Naval Examining Board, engaged in the examination of engineers for promotion, died on Feb. 7 at his home in that city.

Mr. Geo. Royal, Jr., has resigned the Western agency of the Sterlingworth Railway Supply Company, and has accepted a position with the Nathan Manufacturing Company, as Assistant in the Western Department, with office at 147 E. Van Buren Street, Chicago, Ill.

The following changes are officially announced on the San Francisco & North Pacific: Mr. A. W. Foster has been elected General Manager, vice Mr. H. C. Whiting, resigned, and will continue to perform his duties as President. Mr. W. G. Corbaley having resigned, the office of Superintendent was abolished. Mr. H. C. Whiting has been appointed General Superintendent. Mr. F. K. Zook has been appointed Assistant Superintendent, in addition to his duties as Chief Engineer.

The following changes have taken place in the mechanical department of the Atchison, Topeka & Santa Fe: Mr. T. Paxton, Master Mechanic at Nickerson, Kan., is appointed Master Mechanic at Fort Madison, Ia., to succeed Mr. James Collison. Mr. J. E. Gavitt is appointed Master Mechanic at Nickerson, Kan., to succeed Mr. Paxton. Mr. G. T. Neubert, foreman at Wellington, Kan., is appointed Master Mechanic at Arkansas City, Kan., to succeed Mr. John Kirk, resigned. Mr. F. G. Tisdale, foreman at Atchison, Kan., is transferred to Newton to succeed Mr. Gavitt.

Mr. George Royal, Sr., Western Manager of the Nathan Manufacturing Company, died at his home at Oak Park, Ill., Feb. 5, at the age of 59 years. Mr. Royal was born at Manchester, England, in 1837, and came to this country in 1863, entering the Erie shops at Susquehanna as a machinist. In 1868 he was appointed Master Mechanic of the Central Pacific shops at Truckee, Cal. In 1875 he became Master Mechanic and Superintendent of the Eureka & Nevada Road which position he resigned in 1878 to take the Western management of the Nathan Manufacturing Company. Mr. Royal was well known among railroad men; he was a man of deep religious convictions and through his sympathy and work for railroad employees won their respect and confidence everywhere. Some of our readers not personally acquainted with him will remember him as a regular attendant at the June conventions, where he frequently, in the absence of a clergyman, led in the prayer with which those meetings are opened.

Mr. Frank Thomson, who was last month appointed President of the Pennsylvania Railroad Company to succeed Mr. Geo. B. Roberts, deceased, first entered the service of the company at the age of 17, when he entered the car shops at Altoona. At the age of 20 he became the valued assistant of Mr. Scott in the management of the military railroads engaged in moving the Union armies during the Civil War. He was engaged in this responsible work for three years. In 1864 he was appointed Superintendent of the Eastern Division of the Pittsburgh & Erie; in 1873 he became Superintendent of Motive Power of the road; in 1874 he was elected General Manager of the Pennsylvania lines east of Pittsburgh and Erie; in 1882 he became Second Vice-President of the company; and since 1888 he has been First Vice-President. Mr. Thomson has always followed closely the improvements in the details of railroad construction and operation, and many of the improvements of the road in track, stations, safety appliances, etc., originated and have been carried out under his direction. Commenting on his election a Philadelphia writer says: "The election of Mr. Thomson to the Presidency of the great corporation is a guarantee to the public, and to those whose financial intesests are closely associated with and dependent upon the prosperity of the road, that its multifarious activities will continue to be directed with the masterful business sagacity, farsightedness and fidelity which have so long characterized its direction."

The election of Mr. Frank Thomson to succeed the late Geo. B. Roberts as President of the Pennsylvania Railroad Company

has led to several other changes in the high offices in that company. Mr. J. P. Gillen, who has been Second Vice-President, has been elected to Mr. Thomson's former position of First Vice-President; Mr. Charles E. Pugh, formerly Third Vice-President becomes Second Vice-President; Mr. S. M. Prevost, formerly General Manager, is third Vice-President; Mr. Samuel Rea, who was Mr. Roberts' assistant, is First Assistant to the President; Messrs. Wm. A. Patton, who was General Assistant, and Mr. E. T. Postlethwaite, who was Assistant to the First Vice-President, are elected Assistants to the President; Mr. Wm. H. Joyce, formerly General Freight Agent, has been elected to be Freight Traffic Manager, and Mr. J. B. Hutchinson, formerly General Superintendent of Transportation, has been elected General Manager.

The First and Second Vice-Presidents have each advanced one grade, but they will retain in their new positions the duties of the old. Captain Green will have charge of the finances of the company, which he has managed so admirably in the past. Mr. Pugh will retain his special supervision over the affairs of the transportation department, which has been his work since he was elected Third Vice-President, and which he has managed with great success. As Third Vice-President Mr. Prevost will have charge of all the passenger and freight traffic interests. Mr. Rea will be the adviser of the President in engineering matters, a position for which he is eminently fitted. Mr. Patton has been so long connected with the office of the President that his knowledge of the affairs of the company will be invaluable to the new President. Mr. Postlethwaite has been connected with Mr. Thomson in his various positions for about twenty-five years, his responsibilities becoming greater with each advance of his chief, so that he brings to his new position a long training and a wide experience.

George B. Roberts.

Mr. Geo. B. Roberts, President of the Pennsylvania Railroad Company and of the Pennsylvania Company, died Jan. 29, at his home near Bala, Pa. In his death the great railway corporation which was so fortunate as to have his services for about 40 years of his life has lost an officer of noble character and remarkable ability. Mr. Roberts was born Jan. 15, 1833, in Lower Merion Township, Pa. He was educated as a civil engineer at Rensselaer Polytechnic Institute, and in 1851 he entered the service of the Pennsylvania Railroad as a rodman. Later he became assistant engineer of the Philadelphia & Erie road, and for some years after was employed on the construction work of various roads. In 1862 he returned to the Pennsylvania Railroad, and in 1869 became Fourth Vice-President; in 1874 he became First Vice-President, and in 1880 he was elected President. In an admirable tribute to him the Philadelphia Ledger says:

"Few men ever came to the head of a great corporation better qualified by experience and intimate knowledge of its affairs than did Mr. Roberts to the Presidency of this great corporation. He commenced his lifework at the dawn of its existence. To his knowledge of men and the physical characteristics of the system he added that ripe experience in the details of management which his careful attention to every department in the service had brought to him.

"The cardinal principle of his policy was that the business of a corporation should be carried on by those methods which have been most successful in the lives of individuals; that there should be integrity in all things; economy, not parsimony, in expenditures; provision for the future in prosperous times; ownership of what it is wise to control, and keeping up with the general progress of the times. Acting upon these principles, properties were purchased which had formerly been held under leases, and, as the credit of the company improved and money could be obtained on low rates of interest, this policy was extended to the purchase of obligations guaranteed by the company, which were placed in a sinking fund. Profitless enterprises were either abandoned or the burden was shifted upon those who were benefited by them. The policy thus inaugurated was not carried into effect without much opposition, both at home and abroad; but Mr. Roberts was not a man either to be swerved from his convictions or driven from his place. Under this wise financial policy, which has distinguished his company, its credit rose as high as that of the United States during the period of the greatest business depression the country has ever known."

"His skill as an engineer was fully equaled by his abilities as an administrative officer and his genius as a financier. His judgment on questions of finance was notably sound and his associates frequently deferred to him in instances where at first he had stood alone in regard to deciding the policy of the company, in transportation matters connected with the trunk lines and in other grave questions bearing upon the vast interests of which he was the controlling spirit."

Snow-Flanger Operated by Air.—Lake Shore Michigan Southern Railway.

BY OSCAR ANTZ.

The earlier forms of snow plows, which were pushed ahead of the locomotive, were, as their name indicates, a contrivance for cutting into the snow and pushing it to one or both sides of the track. They were made of wood, sometimes faced with iron. Even at the present day, this style of plow is used to a great extent, some in their crude form and some of modern build on more scientific lines. Modern ingenuity has put in the field a number of so-called plows whose principle is to virtually dig out the snow and force it through the machine by centrifugal force out to the side of the roadbed, the power being obtained from an independent engine placed on a car which is pushed ahead of the locomotive.

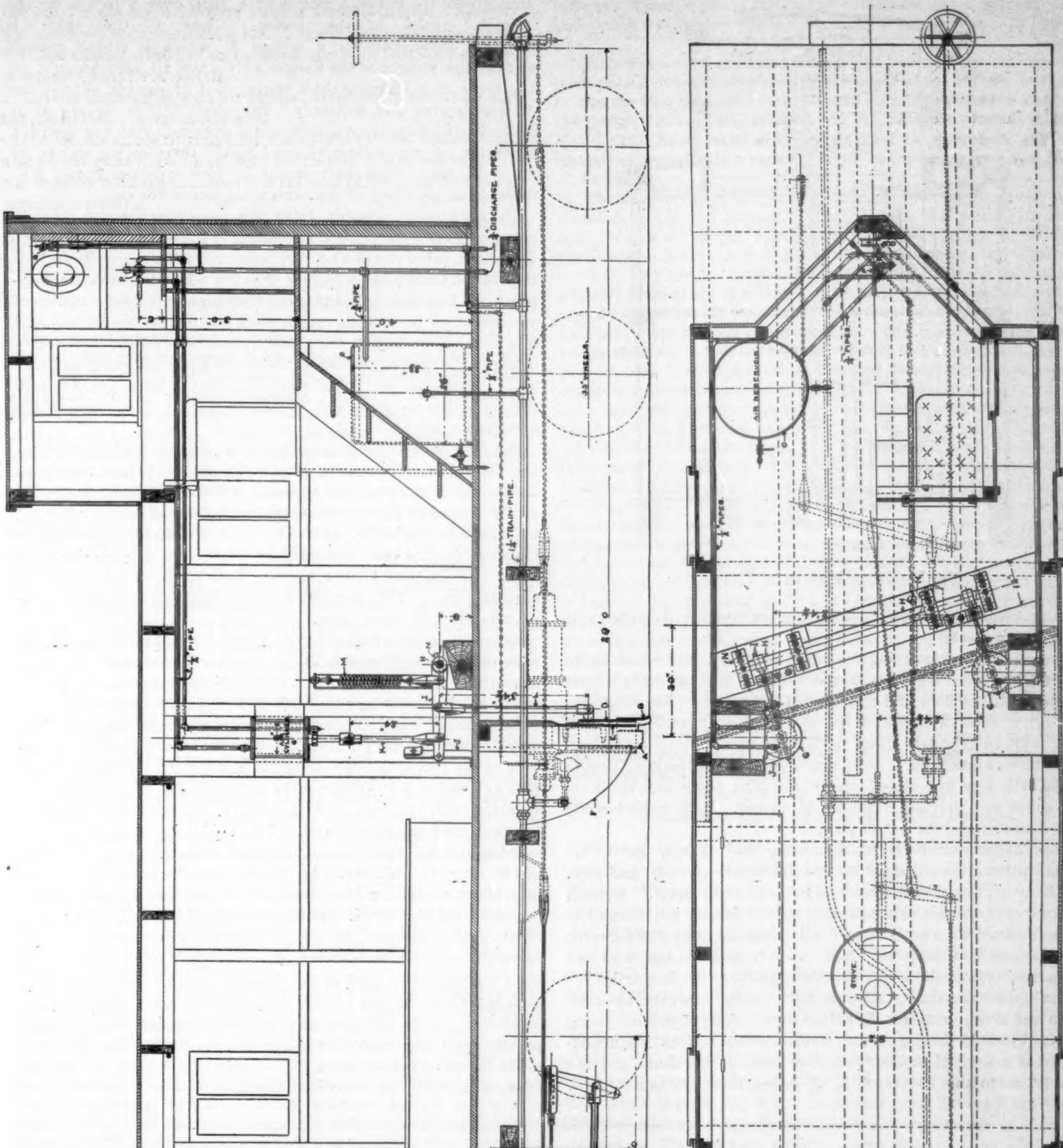
These centrifugal plows, as well as the push plows mentioned, do not, however, take the snow from below the surface of the rail, and this remaining portion, if left in place, forms a good nucleous for a blockade during following storms. A light fall of snow does not always warrant the sending out of the regular plow, and it is for these reasons that a scraper or flanger is used. This is sometimes combined with the snow plow proper, but it is often advisable to have it on a separate car.

A flanger consists of a set of knives of iron or steel, suspended below the body of the car, capable of being raised and lowered, and of such shape as to remove the snow between the rails for about a foot or so from each rail, and also to cut it down slightly on the outside of the rails.

It will be seen that a scraper as described cannot be used where there is anything on top of the ties between the rails, such as at switches, crossovers, street crossings and cattleguards, and provision must therefore be made to raise and lower the scraper as required. This has usually been done by hand, several men on the end of a long lever being usually employed for the purpose. Now it is not unusual to operate the knives of a flanger by compressed air.

The plans shown herewith are taken from a flanger recently constructed by the Lake Shore & Michigan Southern Railway at their carshops in Cleveland. As is usually the case with equipment of this character, this flanger was constructed from an old car, a flat car having been used and the necessary parts added to it. Figs. 1 and 2 represent the plan and sectional elevation and Fig. 3 a cross-section looking towward the front of the car, showing the arrangement of the operating mechanism.

The flanger knives, shown in detail in Fig. 4, consist of five pieces of ½-inch plate steel, *A*, *B* and *C*, which are cut out as follows: Over each rail, the knife *B* is cut out 5 inches wide and 4 inches deep, the outside knives *AA* are 2½ inches shorter than knives *B*, and the center knife *C* is 2½ inches shorter than *B* and tapers still more towards the center. When at the lowest point of their motion, the knife *B* projects 3½ inches below the surface of the rail between the rails, has a ½-inch space between top of rail and bottom of cut-out part and a space of about 1 inch on each side. The knives are made of five pieces, as shown, partly for convenience in manufacture and partly for easy renewal of worn parts. They are riveted or bolted to a piece of ½-inch steel plate, *D*, 15½ inches wide, which is provided with two sets of lugs, to which are connected the rods,



SNOW FLANGER OPERATED BY AIR.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.—Figs. 1 and 2.

which raise and lower it. This plate hangs against pieces of $\frac{3}{8}$ by 2-inch iron riveted to another plate, *E*, and it is guided and prevented from moving away from these bearing pieces by bars of $1\frac{1}{4}$-inch round iron bent in U form, with ends drawn down to 1 inch, forming shoulders, which are fastened to the plate *E*. Slots in plate *D*, in which the U-bolts work, allow it to be raised and lowered. Plate *E* is 21 inches wide, of $\frac{1}{4}$-inch steel and is bolted to cast-iron brackets *F* (see Fig. 2), which in their turn are securely fastened to the bottom of the sills of the car, one to each sill, the bevel on the front face being such as to give the plate *E* an inclination of 30 inches in the width of the car. The space between the top of plate *E* and the bottom of the floor of the car, is filled

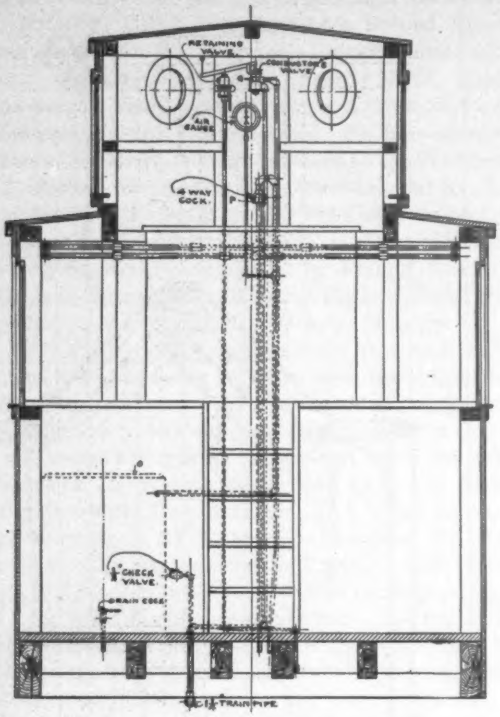


Fig. 3.—Cross-Section of Flanger.

in with wood, to prevent the snow from getting over the plate and back on the track.

The raising and lowering device consists of two 8-inch cylinders *GG*, fastened securely to the sides of the car, at a proper height from the floor and connected to the knives below the car through a series of rods and levers. A pair of ordinary 8-inch freight brake cylinders were used, new heads being made, and the cylinders arranged to be double-acting. The leakage groove in the cylinders are closed up by chipping them out in dovetail shape and driving in pieces of copper. Both cylinders are drilled and capped for $\frac{1}{2}$-inch pipe.

The connections between the pistons and flanger knives are made by using the standard M. C. B. air-brake clevises and pins, the body of the connections being $1\frac{1}{4}$-inch diameter. A shaft, *HH*, extends across the car parallel to the flanger knives, and to it are fastened the two levers *II*, by being shrunk on and keyed; these levers have drilled in them four holes each, the outer one being used to hold the levers and through them the flanger knives in the highest position, while the car is being run over the road when not in use, brackets *JJ* bolted to the floor of the car being provided to hold the pins. The cylinder connections *KK* are attached at a point 21 inches from the center of the shaft and the connection to the knives, *L L*, 12 inches from the same point, thus giving the knives a motion of a little over 6 inches for the 12-inch stroke of the piston. Close to the shaft is another connection for a spring *M*, which is strong enough to raise the weight of the flanger knives and all attachments on the lever, thus insuring their raising out of danger should the air supply give out suddenly. The shaft *HH* is square at its central part, to provide a bearing for a wrench which is used for operating the mechanism by hand should there be no supply of air to be had. The shaft works in four babitted boxes *NN*, fastened to the block of oak, extending across the car.

The air supply is taken from the train-pipe through a $\frac{1}{2}$-inch pipe provided with a check valve and is stored in a reservoir *OO*. The check valve closes when the pressure in the reservoir exceeds that in the train pipe, which is the case when the brakes are applied. It has been found that a $\frac{1}{2}$-inch pipe will feed a sufficient amount of air to the reservoir to work the flanges continually and it is not so large as to reduce the train-line pressure sufficiently to apply the brakes, as long as the air-pump is attached and running. From the reservoir the air is carried to the four-way cock *PP* by a $\frac{3}{4}$-inch pipe, and is distributed by this cock to the cylinders.

The four-way cock has ports to the air supply, the atmosphere and the top and bottom of the two cylinders. The connections are arranged in such a manner that when the handle is thrown up the pistons in the cylinders, and with them the flanger knives, will also move upward, and when thrown down they will be lowered, so that the operator need never be at a loss to know in what position the knives are nor how to move the handle to operate them. The connections from the four-way cock to the cylinders are of $\frac{1}{2}$-inch pipe.

The pipes leading into the cylinders at top and bottom are fitted with plugs through which oil can be introduced and moisture drawn off. The discharge pipe from the four-way cock is $\frac{3}{4}$ inch, and is led down through and below the floor of the car.

The general arrangement of the car is about as follows: The operator stands on a platform raised about four feet from the floor of the car, which is reached by a stairway. A kind of cupola or lookout is built over this platform about three feet higher than the roof, provided at the sides with sliding windows and at the back with stationary ones. The front is on an angle on each side toward the center, and is sheathed solid, with the exception of two circular windows. At the center of the front is a 3 by 12 inch plank extending from floor to roof, and into this are framed the sides and roof of the cupola. On the back of this plank, in front of the operator, are a gage indicating the pressure in the reservoir, a conductor's valve and a pressure retaining valve. A shelf is provided in front of the operator, over which the four-way cock is placed, the space below the shelf being enclosed. The conductor's valve *Q* is connected to the train-pipe in the usual manner, and discharges down through the floor. The old style valve is used, the rope being carried back the length of the cupola, to be within easy reach at all times.

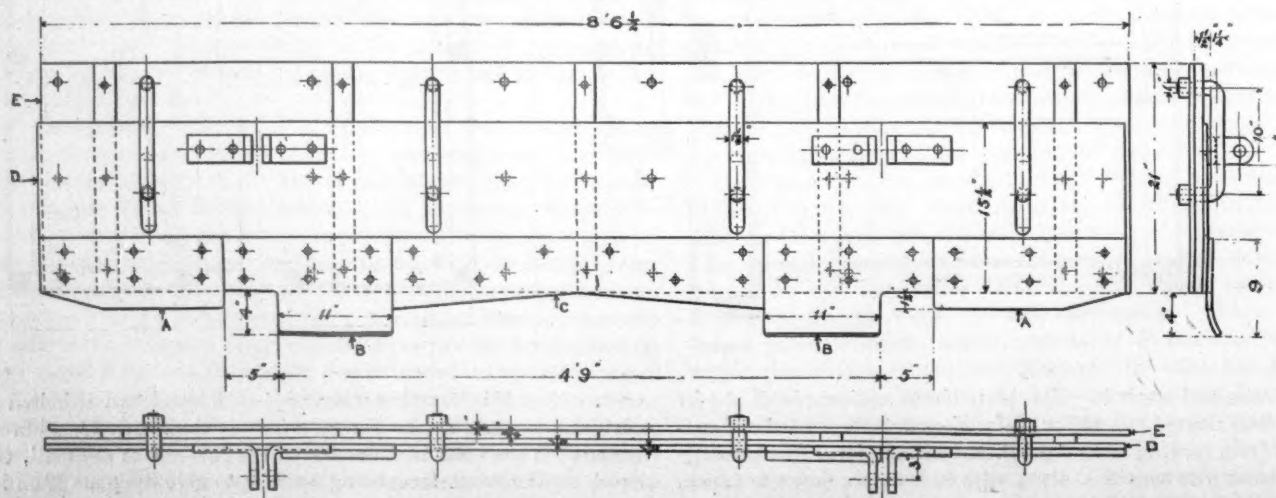


Fig. 4.—Knives of Flanger Operated by Air.

A cushioned seat is provided at each side of the cupola, and in the body of the car, seats with lockers underneath for tools, etc., are arranged for the attendants. A stove provides bodily comfort and sliding windows on the sides and ends furnish light and, when necessary, ventilation.

The car is provided with air brakes, arranged in the usual manner, with brake shaft at one end.

The trucks under the car have inside heavy iron brake beams, and all the parts are kept as high as possible above the rail. The car is fitted with the stands and draft gear of the road and has automatic couplers.

This flanger has been in use since the beginning of the year and has given good satisfaction, the knives being raised or lowered in about two seconds.

American Society of Civil Engineers.

The annual meeting of this society was held in New York on Jan. 20. The officers elected were President, Benjamin M. Harrod, New Orleans; Vice-Presidents, George H. Mendell, San Francisco, and John F. Wallace, Chicago; Treasurer, John Thomson, New York; Directors, Rudolph Hering, New York; James Owen, Newark, N. J.; Henry G. Morse, Wilmington, Del.; Benjamin L. Crosby, St. Louis; Henry S. Haines, Atlanta, Ga.; Lorenzo M. Johnson, Eagle Pass, Tex.

The membership of the society on Jan. 1 was 2,018. The site of the new society house in New York was purchased in 1896 for $80,000, of which $.0,000 in cash has already been paid. From competitive designs for the building, that of Mr. C. L. W. Eidlitz was selected and in December the contract was let for $86,775. The work of excavation, costing $4,500, had been completed and paid for at the time this contract was let. Nearly $20,000 in subscriptions toward the cost of the new house have already been received, and altogether the society has already spent over $32,000 on the house, part of the funds being taken from its savings of past years. The balance in the treasury is $11,456.

The report from the sub-committee of the International Committee on Tests of Steel and Iron will not be forthcoming for several months. The report of the Committee on Units of Measurement will be made at the summer meeting.

The Board of Directors reported on the advisability of appointing a committee to revise the methods of making cement tests. It found reasons for and against such a course, but felt that if the committee was appointed its work should be confined to the methods of testing and should not include specifications for cements. The matter will be submitted to letter ballot.

On Jan. 21, the members of the society visited the works of the new Croton Dam at the invitation of Mr. F. Teley, Chief Engineer of the Croton Aqueduct Commission. The New York Central furnished a special train to Croton, from which point the party was taken to the site in carriages.

The work of excavation and construction excited much interest. The dam is built on rock, the foundation of which is gneiss on the northern side and limestone on the southern side, the point of meeting being under the location of the old river-bed. The disintegrated rock at and near the surface had to be removed to a considerable depth in order to secure a sufficient foundation. The dam is to be built mostly of masonry with an earth embankment on the south side. The spillway over which the water is to flow is placed and partially built on the northern hillside, where a channel has been excavated in the rock for the purpose.

The necessity of securing a firm foundation for the dam has caused a very large excation, which, owing to the poor quality of the rock, has extended to a general average of over 80 feet, with occasional depths of 100 to 110 feet below the original bed of the river. About 40,000 cubic yards of masonry are now laid in the main excavation. In order to protect the excavation from the river, a channel has been excavated on the north side, and the river is diverted by temporary dams built above and below the work and connected with the channel wall. The width of the dam at the lowest point is 200 ft. The height above the old bed of the river is 160 feet. The height above the lowest point of the foundation is 270 feet, the length of the masonry part of the dam is to be 700 feet, and the length of the embankment on the south side, nearly 400 feet.

For removing the material excavated the contractors, Messrs. Coleman, Ryan & Brown, erected three cableways over the site. The cables are two inches and 1,400 feet long from anchorage to anchorage and are stretched across the valley at a height of about 175 feet above the river. They are used not only to take away the material but also to place the stones entering into the masonry, which are quarried about 1¼ miles up the river and brought to the site on a contractor's railway. Trenton and Lidgerwood cableways are employed and their work was highly praised by those who saw them in operation.

Lunch was served at Croton and on the return trip the special train passed over the new drawbridge and viaduct in Park avenue. It was the first passenger train to pass over the structure and at the bridge the train was stopped and the party inspected it, Mr. Katté, Chief Engineer of the road, giving the members any information desired. In a recent account of this enterprise the New York Sun says:

"The new bridge is the first four-track drawbridge ever constructed, and is the largest of the kind in the world. It is 400 feet long and weighs 2,500 tons. The drawbridge is 58 feet 6 inches wide from center to center of outside trusses, and is carried on three very heavy trusses. Between the central and each of the two side trusses is a clear space of 26 feet, which permits the passage of two sets of double tracks. The floor is corrugated, and the rails are bolted to it on steel tie-plates. The trusses of the drawbridge span are 64 feet in the center and 25 feet at each end. At the highest part of these trusses is situated the engine-house, which contains two oscillating double cylinder engines, which turn the draw, and can be worked together or separately, so that if one should break down at any time the other can do the work. The bridge crosses the river at an angle, and its shore piers are built withn the channel line, so that when the draw is open it leaves the whole width of the river clear, except the space taken by the central pier.

"The Harlem River, having been declared by Congress a ship canal, the Secretary of War has issued orders that all tugs and barges shall joint their smokestacks and flagpoles, to enable them to pass under the bridge while it is closed. He has also ordered that the bridge shall not be opened between the hours of 7 and 10 o'clock in the morning, and 4 and 7 in the afternoon, except for police, fire or government vessels, the hours named covering the great business traffic in and out of the city, the important through trains as well as the principal suburban trains arriving and departing during those hours. Above and below the Harlem the tracks are carried on a steel viaduct. A new station is being built at 125th street. This will occupy the whole block from 125th street to 126th street, under the viaduct. The cost of the work that has already been done, up to Feb. 1, is $1,687,208, and of this the bridge alone has cost about $700,000."

Pneumatic Grain Elevator on the Danube.

Steamers loading with grain at ports on the River Danube frequently have to be lightened before they can get to the ocean, because of the sudden changes in the state of the river. Grain taken out of a steamer under these conditions is loaded on barges and by them transported to the river's mouth, where it is again placed on the steamer. This work of transfer was formerly done by hand, but is now accomplished by a pneumatic grain elevator. Engineering says that the first vessel carrying one of these elevators is built entirely of steel, and is 130 feet long by 22 feet beam by 11 feet deep. The machinery consists of two multitubular marine type boilers 9 feet 6 inches diameter by 10 feet long, and each boiler has two furnaces of 2 feet 4½ inches diameter. The pneumatic engines are of the horizontal type, having a high-pressure cylinder 22 inches diameter and a low-pressure of 42 inches diameter. The stroke is 4 feet. There are four air cylinders, each 38 inches in diameter, and the engine will bevelop 470 indicated horse-power. The air is exhausted by the pneumatic engine from two large steel tanks or receivers placed at 30-foot centers amidships of the vessel, and carried on steel towers. The extreme height of these structures is 61 feet above the water level, and is sufficient to allow of the grain running by gravity through the shoots into the largest ocean vessel. The suction pipes through which the grain is lifted from the barges into the receivers can be attached on either the port or starboard side. The grain when lifted falls to the bottom of the receivers, and the air is separated and drawn off from the top. The grain passes from the receivers into boxes which are divided into two air-tight sections, and oscillate on pivots, so that one side is being filled with grain as the other is discharging its load, the weight of the grain on one side or the other giving the necessary see-saw movement to the apparatus. The grain then falls on to iron trays resting on pivots fore and aft, so that it can be delivered down the incline given to the trays on which-

Elevation of Reconstructed Grand Central Station, New York City.

ever side may be desired. The exhaust air, after leaving the pneumatic cylinders, is delivered into quieting chambers placed at the extreme ends of the boat, and thence escapes without noise into the atmosphere. The elevator will transfer 140 tons per hour at a very low cost.

Reconstruction of the Grand Central Station in New York City.

For some time past plans have been under consideration for the re-arrangement and enlargement of the Grand Central Station in New York City, and recently the whole matter was put in charge of Mr. John M. Toucey, General Manager. Mr. Walter Katté, Chief Engineer of the road, and Mr. Bradford L. Gilbert, architect, have respectively taken care of the engineering and architectural work.

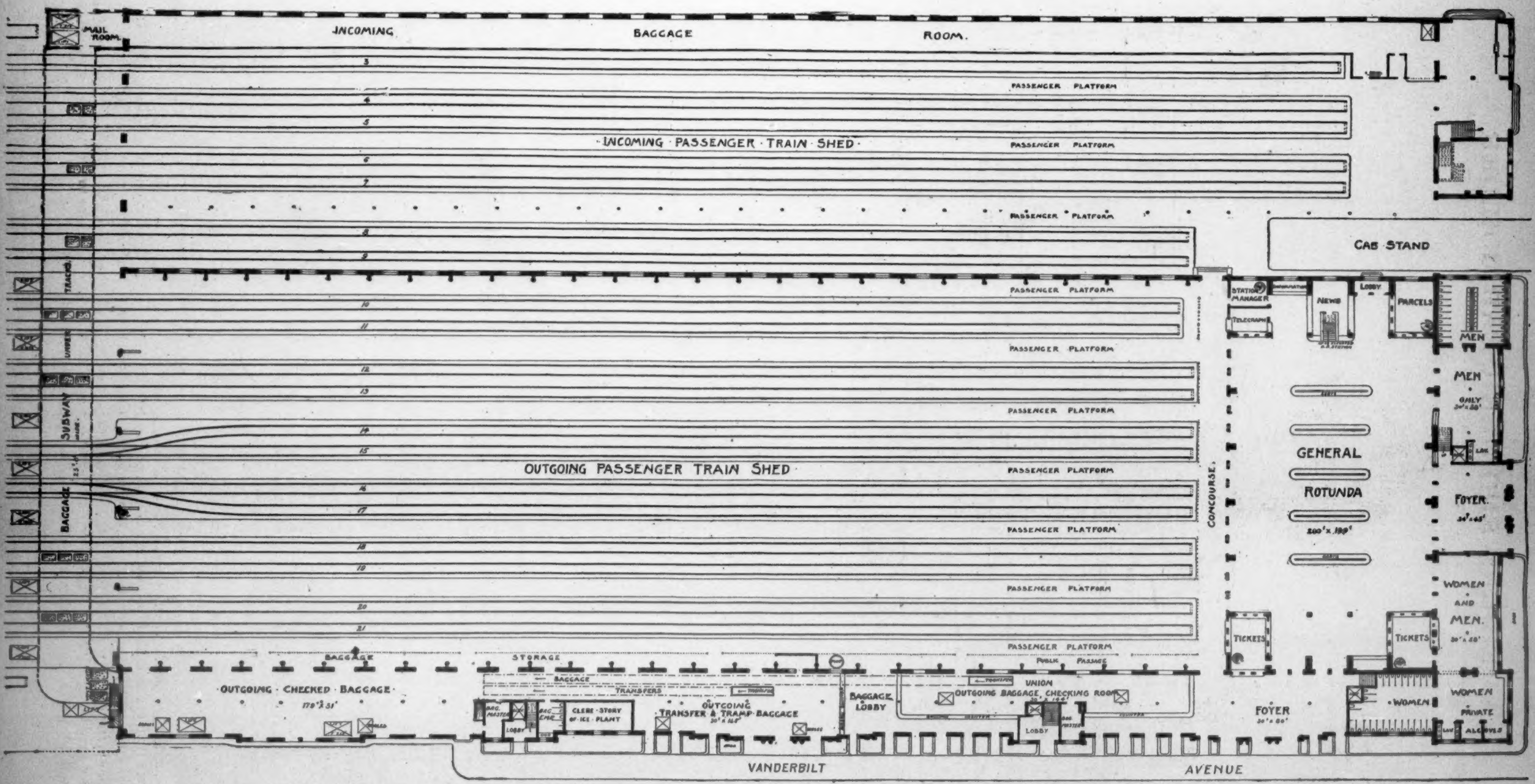
This well-known station was built 27 years ago, and since its erection the traffic of the three roads entering it has grown enormously. At present the number of passengers handled, in and out, is in round numbers eleven and one-half millions yearly. The building has at present three waiting-rooms, one for each road, and the New York Central room in particular is so situated as to be convenient to only a few of the tracks in the train-shed. The plans for the reconstruction provide for the consolidation of all the passenger business into one large waiting-room with its auxiliary baggage-rooms, ticket offices, ladies' rooms, smoking-rooms, toilets, etc. This would in itself increase the number of people that can be handled daily at the station, but further provision is made for their comfort by largely increasing the floor area of these rooms.

The general waiting-room is to be located at the south end of the present train-shed (see plan), and will be 100 feet wide and 200 feet long, making what is to be the largest waiting-room in the world. Its roof will be arched and will be constructed of steel, iron and glass. The room will have an entrance on Forty-second street through a foyer 34 by 45 feet, one on Vanderbilt avenue through a foyer 30 by 60 feet, and through vestibules from the incoming station on the east side of the room. Opening off the large room is a smaller general waiting-room 30 by 58 feet. Other rooms are a ladies room 34 by 34 feet, ladies' toilet 20 by 30 feet, smoking-room 30 by 58 feet, gentlemen's toilet 35 by 35 feet and ticket-offices with 20 windows. The combined waiting-rooms of the station, as it is to-day, have a floor area of about 12,000 square feet; the reconstructed station will have 28,000 square feet, exclusive of toilet-rooms and platforms.

The baggage-rooms are to be along the west side of the train-shed, on Vanderbilt avenue. There is to be an outgoing baggage-checking room 30 by 144 feet, an outgoing baggage-transfer room 30 by 165 feet, and an outgoing checked-baggage room 31 by 179 feet. The incoming baggage-rooms are in the station for incoming trains, to the east of the main station, as at present. The three outgoing-baggage rooms mentioned are provided with platform conveyors, by which the baggage is carried under the floor to the basement at the extreme north end of the building, where it will be put on baggage trucks and taken through a subway 25 feet wide, extending under all the tracks. At each passenger platform there will be a baggage lift, to raise the baggage from the subway to the platform.

The office part of the building will also be greatly enlarged. Two stories will be added and the present office floor area of 55,000 square feet increased to 133,000 square feet. A new power plant of 1,750 horse-power will be installed for the electric lighting of the station, offices, train-shed and yards outside. It will also supply power for the baggage transfers and lifts, and for the elevators to be put in for reaching the offices. The heating and plumbing will be new. There will also be an ice plant with a maximum capacity of 40 tons per day.

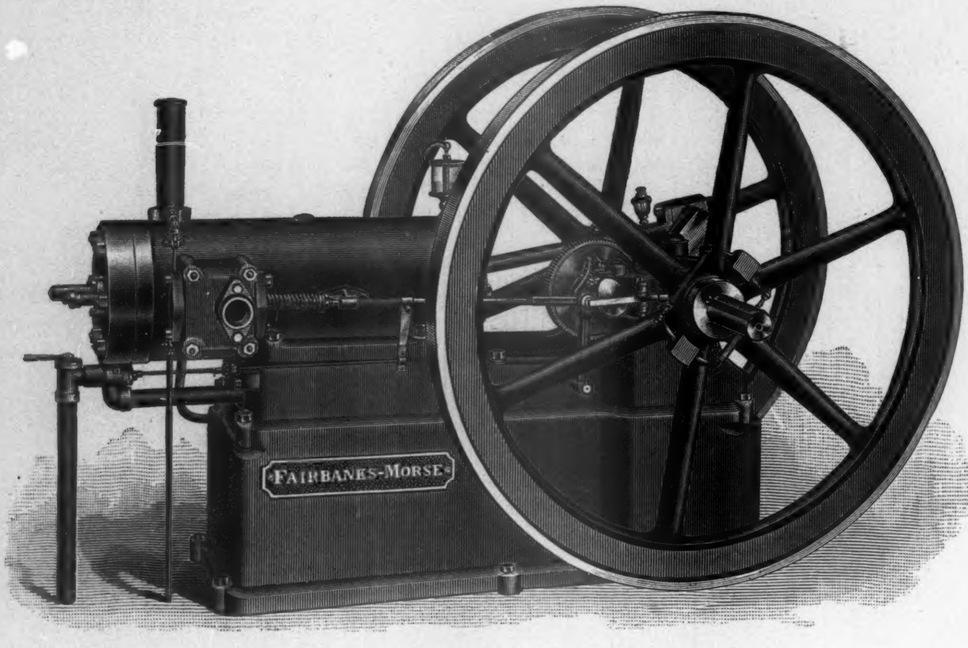
The exterior of the building is to be altered considerably, but Mr. Gilbert's aim has been to combine the new with the old so that it will harmonize completely. The entire exterior of the plain brick walls will be covered with a Portland cement stucco, which will give the effect of a solid, rough gray background, with trimmings of white. The cost of the new work on the building proper, exclusive of the power plant, is placed at about $500,000, but the cost of the alterations of that portion of the present building which is to be utilized are not stated. When completed it will be one of the finest stations in the world in all its appointments.



GENERAL PLAN OF RECONSTRUCTED GRAND CENTRAL STATION, NEW YORK CITY.

The Fairbanks-Morse Gas Engine.

The gas and gasoline engines made by Fairbanks, Morse & Company, of Chicago, have earned for themselves an excellent reputation for economy and durability. These engines run at slower speeds than is customary in gas engine practice, the speed of a 10 horse-power engine being 225 revolutions per minute, a 20 horse-power engine 175, a 50 horse-power engine 160, a 75 horse-power engine 150 revolutions, etc. This moderate speed, accompanied by simplicity of design and substantial construction, gives great durability to the engine.



The Fairbanks-Morse Gas Engine.

It is made in sizes up to 100 horse-power with a single cylinder, which is as large as any made in this country in which the power is generated in one cylinder only. The two horse-power engine is vertical, but all other sizes are of the horizontal type. The engraving herewith shows one of these gas engines, the view being taken of the side on which the valve gear is located. The simplicity of the engine will be the more apparent when we state that there is no mechanism on the other side of the cylinder except a starter, to which we will refer later.

The engine operates on what is generally called the "Otto" cycle that is, there is one working stroke in every two revolutions. There are only two positively operated valves to the engine and they are both of the poppet type. One is the exhaust valve, located within the rectangular chamber on the side of the cylinder, and the other is the gas valve, directly under the cylinder head. A suction valve in the cylinder head admits air on the charging stroke. These valves are water-jacketed. There is but one cam, which, by means of a straight rod carried in suitable guides, operates the exhaust value and also controls the gas valve.

The governor is clearly seen in our illustration. It is attached to the hub of the flywheel and acts directly on the exhaust valve. When the speed of the engine rises slightly above normal the governor moves the short horizontal lever, one end of which is seen in front of the cam, and this end engages the rod operating the exhaust valve at a time when that valve is open, and prevents the valve from closing. At ths same time the connection between this rod and the gas valve keeps the latter closed until the speed falls to normal, when the governor releases the valve gear. Consequently, no charge enters the cylinder, and the exaust valve being open, there is no useless compression to add to the friction of the engine. It will be noticed that the cam for operating the valves is placed on a shaft driven from the main shaft by two to one gearing, and that the entire governing mechanism is right at this point, thus making a compact arrangement.

The ignition is accomplished either by an electric spark or by a hot tube. By careful attention to details both of these methods have been made unusually satisfactory. Our illustration shows the hot-tube ignition.

The ease with which the engine can be started is another of its good features. On the other side of the cylinder from that seen in our engraving is a small hand pump by which a charge of gas and air can be pumped into the engine cylinder. Before this is done a detonator plug is removed from the cylinder and the end of a match stuck in it, after which it is replaced. When the cylinder has been charged, a smart rap with the hand on the knob of the detonator lights the match and explodes the charge, giving power enough in the cylinder to start the engine under a two-thirds load. This starter can be used with either the electric igniter or the tube igniter, as it is entirely independent of them. This allows the starter charge to be fired at the most desirable time, giving the best results in starting.

It will be noticed that the cylinder is unusually long. The reason for this is that a very long piston is employed, and it is packed with five rings.

The gasoline engine is as simple as the gas engine, and in a 20 horse-power engine with gasoline at eight cents per gallon, will give a horse-power for about four-fifths of a cent per hour.

It is claimed for these engines that they are unusually economical under light loads, and users of gas engines know this to be an important point. This claim is based in part on the absence of compression when the governor has prevented charges from entering the cylinder.

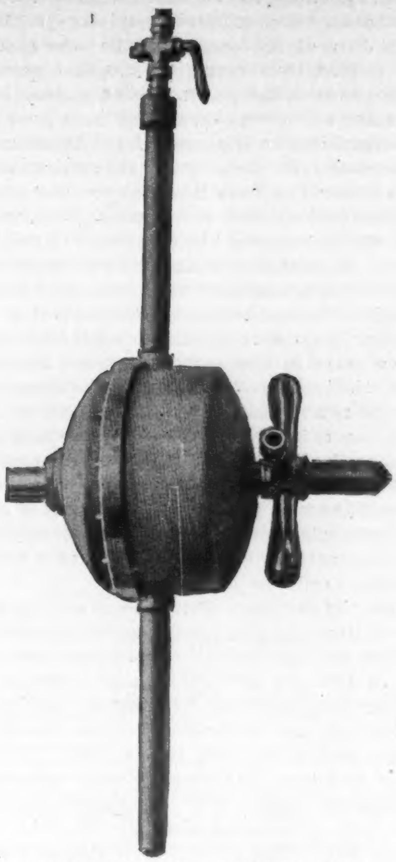
These engines are built for general power purposes, and are also adopted for special uses. For water pumping they are directly geared to a pump mounted on the same base, making a self-contained plant.

The Boyer Piston Air Drill.

In the various applications of compressed air in shops motors of the rotary type have thus far predominated, but with the increasing demand for small motors there has arisen a dissatisfaction with the rotary because of its extravagance in the use of air. The piston air drill recently perfected by Mr. Boyer and placed on the market by the Chicago Pneumatic Tool Company therefore makes its debut at an opportune time. Like all of Mr. Boyer's productions, it is ingenious and designed on original lines, while the details have been worked out with skill and painstaking care. In the accompanying illustrations we give a view of the motor complete, as designed for light work, such as tapping staybolt holes, reaming, drilling, etc.; a second view shows the motor taken apart separated sufficiently to make clear the method of construction.

The motor has three 2-inch cylinders, seen under the arms of the triangular piece in the middle of Fig. 2. Their pistons are connected to a single crank fitted with ball bearings. The crank is fixed, however, and the cylinders travel around it, being carried on the triangular piece already mentioned. A small pinion (not shown) is attached to this triangular member and meshes into the two gears shown in that part of the casing to the left in Fig. 2. These gears also mesh with the internal gear seen on the casing and are journaled on a frame under them which carries the drill chuck. Thus the cylinders revolve bodily on their framework and the gears seen revolve within the casing on a frame to which the drill chuck is attached, but at a much lower speed than that of the cylinders. With 100 pounds air pressure and the gearing down, the power at the spindle is considerable—all that can be used in a hand drill. It is claimed that the motor will drill a 2½-inch hole.

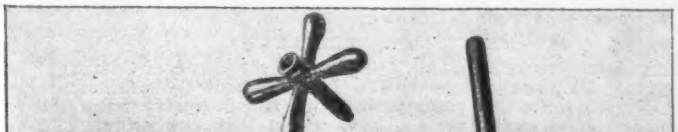
In addition to its economy in the use of air—some tests place



The Boyer Piston Air Drill—Fig. 1.

its consumption at one-fourth that of a rotary—the motor has the advantages of being in perfect balance and weighing complete only 26 pounds. The balance is said to be so perfect that even at speeds of 1,500 revolutions per minute the vibration cannot be felt.

The cylinders are made of machine steel, their frames of cast steel, the gears and pinions of cast steel, the feed screw and star



The Boyer Piston Air Drill—Fig. 2.

of steel, and the casing of malleable iron or bronze, so that it is evident the best of materials enter into its construction. The workmanship is equally good.

The uses of such a motor are too well known to require enumeration on our part. Larger sizes of the motor can be adapted to many power purposes requiring either fixed or portable motors. The offices of the Chicago Pneumatic Tool Company are in the Monadnock Block, Chicago, Ill.

New Publications.

THE STEAM NAVY OF THE UNITED STATES. By Frank M. Bennett, Past Assistant Engineer, United States Navy.

We have before us a large octavo volume of 950 pages bearing the above title. It is published by Warren & Company, 416 Wood street, Pittsburgh, and is further described on its title page as "A history of the growth of the steam vessel of war in the U. S. Navy, and of the naval engineer corps." Value and embellishment are added by a great number of illustrations, many of them full-page half-tone plates, showing types of ships and machinery, old and new, and portraits of distinguished engineers.

As a history of the influence steam and machinery have exerted upon naval tactics and methods the volume is complete, and, while of deep interest to all reading and thinking men now, will serve in the future as a mine of information to readers and historians who may desire to know the details of the complete transformation that has come upon all navies during this century. Previous naval histories and accounts of naval operations, particularly those written by officers of the sailor branch of the navy, have kept the engineer and the idea of machinery in the background, as though sailors and sails were the only elements in the navy. This unwarranted slight is fully overcome by the array of facts presented by our author, who shows that the engineer, fighting against the very element that should have welcomed him, has not only brought the navy into its condition of efficiency, but has also enabled his antagonists to achieve professional honors by means of the innovations he forced upon them.

The first steam war-vessel ever built was an American invention. This was the *Demologos*, known on the navy list as the *Fulton*, designed and built by Robert Fulton in New York during the war of 1812. This ship was 156 feet long, 56 feet beam, and of about 2,500 tons displacement; she mounted 20 heavy guns and was propelled by a central paddle-wheel driven by a single engine and boiler of primitive type. No masts or sails were provided in Fulton's plans, the vessel being in his intention a "steam-battery," and this, by the way, is all that a modern battleship is when stripped of the refinements of science that are not essential to it. When the *Fulton* was nearly completed (in 1814) Capt. David Porter returned home from his disastrous cruise in the *Essex* and was assigned to the command of the new steamer. Porter was a fine old seaman of the wooden age and had no faith in steam; he caused heavy masts to be stepped in the *Fulton* to carry lateen sails and had the ship's sides built up to form walls to protect the sailors who thus became needed to handle those sails. The original and sensible intention was to have an engineer's crew for the working of the ship and artillerymen for the battery, but Captain Porter did not propose to allow anything to float without sails and sailors. Thus at the first possible opportunity did the sailor seek to nullify the efforts of the engineer, and this antagonism crops out prominently throughout the whole history of the application of steam to naval purposes. One of its most modern demonstrations is the influence that put sails upon the *Chicago* and tried to put them on the *Maine*.

The *Fulton* unfortunately was not completed until peace with Great Britain had been declared, and the opportunity of testing her in battle against sailing ships was therefore lacking. She had some very satisfactory steam trials during the summer of 1815 and was then laid up at the Brooklyn Navy Yard as a receiving ship. In 1829 her magazine blew up, completely destroying her and killing many people.

In 1835 the Secretary of the Navy unearthed an act of Congress of 1816, authorizing the construction of another steam battery, which act had been ignored by the worthy commodores composing the Board of Navy Commissioners. After considerable correspondence between this board and the Secretary work on the new vessel was begun at the New York Navy Yard. This vessel was also named *Fulton* and was completed in 1837; she was 180 feet long, 35 feet beam and of about 1,200 tons displacement. Independent side-wheels each driven by a separate engine supplied the motive power, the engines being located on the upper deck over the boilers. A speed of 12 knots was maintained easily, and her Captain, Mathew C. Perry, reported that she was a match for any number of sailing ships of war. A picture of her which the author presents shows a barkentine-rigged steamer not unlike in appearance the few side-wheel sea-going steamers that still exist. A page of her engine-room log is also reproduced and is a genuine professional curiosity.

Two much larger side-wheel steamers were begun in 1839 and completed in 1842; these were the *Mississippi* and *Missouri*, sister ships 229 feet long, 40 feet beam and of about 3,200 tons displace-

ment, carrying 19,000 square feet of canvas to their great detriment. The *Missouri* was burned in Gibraltar in 1843 owing to the carelessness of a storeroom keeper who broke a demijohn of spirits of turpentine. The side-wheel gunboat *Michigan* was built at this same period, the work being done in Pittsburgh and the parts carried overland to Erie, where they were put together and the ship launched in 1843. She was the first iron vessel in the navy and is still in service with her original engines.

Considerable experimental engineering was indulged in by the Navy Department during the forties. Lieut. W. W. Hunter, of the navy, patented a submerged horizontal paddle-wheel for propelling ships and obtained authority from the department to carry out his ideas. Three steamers—the *Union*, *Water-Witch* and *Alleghany*—were built according to his plans and were all failures, as every one at all familiar with mechanical laws knew they would be. Mr. Hunter's wheels were well designed for churns, but they were not adapted for propelling purposes. While the Hunter wheel fallacy was being tried, a real engineer—John Ericsson—was carrying to success his system of submerged propulsion by the use of a screw propeller. The naval steamer built for this experiment was the *Princeton*, the first screw-propelled war vessel ever built, and as her success put an end to experiments with methods of propulsion and made it possible to locate machinery below the water line she is justly credited with being the germ of our steam navy. Ericsson's connection with this famous vessel and his troubles with Captain Stockton of the navy, who tried to appropriate credit for Ericsson's inventions, are told in detail. During this experimental period also was begun that famous ironclad construction known as the "Stevens Battery" the history of which is carefully told.

Sailing ships were used at first in the Mexican war, but the superiority of steamers was so obvious that the Navy Department eventually employed a considerable number of small steam vessels acquired by purchase or charter. This was brought about chiefly by the efforts of Capt. M. C. Perry, who was about the only Captain of the period who did not despise steam. At the close of that war a systematic programme of building a steam navy was inaugurated. The first steamers thus created were the *Powhatan* and *Susquehanna*, with side wheels, they being enlarged and improved *Mississippis*, but thereafter the screw propeller came into general use. The author describes in detail the ship and machinery construction from 1850 to 1860, which gave us the *Merrimac* class of screw frigates, and the *Hartford*, *Dacotah* and *Narragansett* classes of screw sloops, 18 fine steamers in all, to which number may be added six smaller steamers purchased and armed in 1859 for the Paraguay expedition. One of the large screw sloops—the *Pensacola*—had remarkable expansion engines, designed by Mr. E. M. Dickerson, which are technically described by our author in the body of his work and humorously described in an appendix entitled "Uncle Sam's Whistle and What it Costs."

Warship construction during the Civil War assumed such magnitude that the task of describing it is great, but Mr. Bennett has patiently gone through all the records and arranged for his readers a connected and illustrated account of all the types of ships then called into being, from the little "ninety day" gunboats and "double-enders" up to the big cruisers. As a matter of course the monitors and other mastless ironclads, essentially engineers' ships, receive special description, and considerable space is given to the construction and trial trips of the swift cruisers brought into existence by the conditions of war. When the war ended the navy fell into a disgraceful state of decay, interrupted only by the irregular and illegal shipbuilding efforts of Mr. Secretary Robeson during the seventies. The manner in which he "repaired" old sailing ships into steam sloops, and transformed decayed wooden monitors into iron turret-ships has always been a mystery to the public and even puzzled the Congressional Committee that investigated his administration, but we think Mr. Bennett has condensed from the mass of documents in the case as clear and concise a statement of the facts as has ever been given to the public. The revival of interest in the navy that led to the beginning of its rehabilitation, the proceedings of the advisory boards, and the progress of the new navy are excellently described in the concluding chapters of this invaluable book.

The foregoing outlines the scope of this work so far as the history of the growth of steam in the navy is concerned. Woven in with the story of the steamship is the story of the man who made the steamship possible—the engineer. When the second *Fulton* was being built the Board of Naval Commissioners was driven to the sore extremity of asking the Secretary of the Navy for an engineer to furnish advice and superintend the construction of the machinery. After some delay Mr. Chas. H. Haswell, of New York, was, in February, 1836, appointed to "furnish draughts" to the board for a term of two months, for which service it was specified he should receive $250. In July of the same year he was appointed Chief Engineer of the *Fulton*, thus becoming the first person who held the position of engineer in the navy. About a year later Captain Perry took command of the *Fulton*, and at once gave attention to the question of organizing an engineers' force, there being then no assistant engineers and no firemen for the ship, and no apparent intention on the part of the Navy Board to provide them.

Perry's recommendations were not heeded until the vessel was ready for steam and he reported his inability to move her without the desired force. Regulations on the subject were then issued and Perry appointed four assistant engineers, in conformity with their provisions, but the appointments were revocable at the will of the Commander. Engineers for other vessels were appointed in the few following years in this same temporary manner, until, in 1842, Congress, at the instance of the engineers themselves, created the Engineer Corps as a recognized arm of the naval service and specified its members to be officers and that Chief Engineers should be commissioned by the President. The same act created the office of Engineer-in-Chief of the Navy. Mr. Haswell became Engineer-in-Chief in 1844 and the next year performed an act of lasting benefit for the corps by causing all engineers in the service to undergo a competitive examination, from the results of which they were arranged in grades in order of proficiency.

By orders issued by the Navy Department and by Acts of Congress from time to time the requirements for admission and promotion in the corps and the pay of its members have been gradually improved. In 1866 the admirable Cadet-Engineer system at the Naval Academy was instituted by Congress, the history of the inception, development and destruction of this system being told in one of the interesting chapters of the work. The same year First and Second Assistant Engineers became commissioned officers by Act of Congress, and in 1870 the grade of Third Assistant was merged into that of Second Assistant. The titles of First and Second Assistants were changed in 1874 to Passed Assistant and Assistant Engineer respectively.

By persistent warfare with the sailor-officers of the navy the engineers have overthrown sentimental bigotry regarding sails. Such ships as the *Princeton*, *Monitor* and *Wampanoag* were typical, and were the forerunners of military factors that are now combined to make the fighting leviathan of to-day.

The engineers of the navy have thus realized their conception of the proper type of fighting ship, but they have not yet succeeded in gaining official recognition for themselves. They are considered as "non-combatants." In one of Mr. Bennett's chapters he presents data taken from the files of the Surgeon-General's office from which it appears that during the four years of the Civil War 115 members of the Naval Engineer Corps were killed in battle or died of wounds or disease incident to the service. A tabulated list gives further the names of over 100 naval engineers who, during the same period, were killed or injured by violent means, a majority of them by gunshot wounds. Non-combatants, indeed!

THE HOME STUDY MAGAZINE.—The Colliery Engineer Company, Scranton, Pa., proprietors of The International Correspondence Schools, announce that commencing with the February issue the name of the journal, Home Study, which they publish, will be changed to Home Study Magazine; the page will be reduced to magazine size, but the number of pages will be doubled. The articles relating to particular branches of industrial science will be grouped in separate issues. Articles relating to Steam Engineering will be published in the February and August issues; those on Plumbing, Heating and Ventilation in the March and September issues, etc. Each issue will contain other articles, but, as a rule, the general reading portion will consist principally of articles on some particular technical subject. More space will be given to the Answers to Inquiries Department. Each issue will also contain a drawing plate with instructions for drawing it, and an effort will be made to adapt the plate to the subject treated in the issue in which it appears. The subscription price is $1.50 a year, but subscriptions will be accepted at 30 cents for any of the two-number editions.

Books Received.

SKETCHES IN CRUDE OIL. By John J. McLaurin, Harrisburg, Pa. Published by the Author.

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES NAVY FOR 1896. Six volumes. Government Printing Office, Washington.

The Maine Central, the official organ of the Maine Central Railroad, appears this month under a new management, it having been placed under the charge and personal supervision of Col. F. E. Boothby, General Passenger Agent, and it will hereafter be issued from his office. This paper has probably done more to ad-

vertise the State of Maine summer resorts than any other medium, and under Colonel Boothby's charge it will unquestionably prove a greater drawing card than ever in inducing the sojourner to make Maine his permanent summer home. It will, however, be the aim of the new management to make its interests of greater diversity, so that it will reach all classes of travel within as well as without the borders of the New England States.

The February number is devoted to the scenic and tourist attractions of New Brunswick and the Provinces, the Maine Central Railroad forming the connecting link of the all-rail line reaching all parts of New Brunswick, Nova Scotia and Cape Breton.

The March number of the Maine Central is to be devoted to hunting and fishing, and besides the regular circulation to the subscribers, to 17 newspaper agencies, to 50 prominent newspapers, to the principal clubs in every city in the United States, to all the leading hotels, to Maine Central agents and employees, the recreation department of the Outlook and Review of Reviews, among the patrons traveling on the Maine Central trains, to parties from all over the country who write each month to the General Passenger Department for copies containing descriptions of the summer resorts which they wish to visit; nearly 10,000 copies are to be distributed from the Maine Camp at the Sportsmen's Exposition to be held at Madison Square Garden, in New York City, the week of March 15 to 20.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CRANES. The Brown Hoisting and Conveying Machine Company, Cleveland, O., 1897. 90 pages, 6 inches by 9 inches. (Standard size.)

This catalogue contains many half-tone engravings of various types of cranes made by this company, the cranes being fitted for hand or power, as required. They include traveling cranes, locomotive cranes, jib and pillar cranes, derricks, stationary bridge cranes, steam and electric transfer tables, truck cranes, overhead tram-rails, crabs and winches. Special attention is directed to the electric traveling cranes, and also to the company's very convenient hand traveling cranes adapted for light work. The company also makes pneumatic, hydraulic and steam hoists, which are illustrated and described in this book. The illustrations are nearly all full page, and present a large array of hoisting and transferring apparatus from which a purchaser can make a choice. The company has offices in Cleveland, New York Chicago and Pittsburg.

THE MCKEE BRAKE SLACK ADJUSTER. The Q & C Company, Chicago, Ill., 1897. 32 pages, 6 by 9 inches. (Standard size.)

We have on several occasions made the statement that trade literature often contains the best general information available in the field covered by those particular publications. The pamphlet before us is another excellent example of this truth. Comparatively little space is given to the McKee brake slack adjuster itself, which was illustrated in the pages of this journal nearly one year ago, but the general subject of adjustment of brakes is handled in excellent fashion and information valuable to every air-brake man is given. The meaning of total leverage is first made plain. Then follows a demonstration of the inefficiency of hand adjustment of brakes that should lead railroad officers to realize how much more there is in the problem than the simple question of how frequently brakes must be adjusted by hand if automatic devices are not employed. Brakes may be adjusted alike by hand but they will not remain so and the differences in piston travel, even if not very great, will cause great differences in brake power, particularly with moderate pressures on the one hand or short travels on the other. Then the release of brakes whose piston travels are unequal is not prompt after a heavy application and the longer the train the greater the trouble.

It is a fact not generally known that the piston travel measured while a car is standing still is never as great by an inch or two as when running. The reason for this is brought out and its effect discussed in this pamphlet. Lost travel, false travel, shoe clearance, angularity of levers, necessity of close adjustment, etc., are all considered, and the pages dealing with this subject are worthy of a careful reading.

It is a somewhat remarkable fact that the efforts made to introduce automatic adjusters have done more than anything else to open the eyes of car men and air-brake men to the bad effect of many practices in putting up brakes on cars and in the design and construction of their details. For this reason alone such literature on adjusters, as we have before us, should be widely read. And when we add to this reason another one founded on the excellence of the particular adjuster herein illustrated and described, and our belief that it is the best now on the market, we have explained why we urge our readers interested in air-brakes to send for a copy of the pamphlet.

Portable Hydraulic Riveting Machines—Bement, Miles & Company.

The well-known firm of Bement, Miles & Company have built a large number of riveting plants operated by hydraulic power, steam or compressed air, and their line of stationary hydraulic riveters includes machines measuring 60, 72, 84, 96, 108, 120, 144, 172 and 198 inches depth of throat. These larger sizes, particularly the last-mentioned one, whose throat is 16 feet deep, are wonderfully heavy machines. In all these sizes the actual depth of throat is from 2 to 4 inches greater than the nominal depth given above. The company manufacture these machines either with a solid steel frame or with the stake and frame in separate parts bolted together.

The firm has recently designed a new type of machine which is extremely well adapted for some classes of work. We illustrate two styles of these machines; one arranged to revolve horizontally and the other to swing vertically. Either style of machine can be made with any depth or shape of gap required. In both styles the riveter is mounted on a suitable standard or frame and can be revolved about an axis. Through this axis the water pressure is led to the hydraulic cylinder, thus making the water connections quite simple. In each case the cylinder is at the opposite end of the riveter from the dies.

Hydraulic Riveter.—Bement, Miles & Company.

The portable riveters made by this company are in sizes from 2 to 60 inches depth of throat and may be suspended so that the gap will be in either a horizontal or vertical position.

They also manufacture accumulators of all sizes and two sizes of belt-driven pumps. The No. 2 size has a capacity of 8 gallons per minute against 1,500 pounds per square inch pressure when running 100 revolutions per minute. The other size, No. 3, has a capacity of 21 gallons per minute against 1,500 pounds pressure per square inch when running 240 revolutions per minute. The amount

of water and the size of accumulator required for operating a hydraulic riveting plant are governed by the amount of work to be done. Experience has shown the firm that one riveter alone requires a pump with a capacity of 16 to 20 gallons per minute and an accumulator with six-inch ram and six-foot stroke; one riveter and a crane will require a 30-gallon pump and an 8-inch by 10-foot accumulator. Two riveters and two cranes, or doubling the machines, will not require doubling the pump and accumulator; about 50 per cent. increase will be required, say a 50-gallon pump and a 10-inch by 10-foot accumulator, for two riveters and two cranes. For a flanging machine with 28 or 30-inch cylinder, one or two

Hydraulic Riveter.—Bement, Miles & Company.

riveters and one or two cranes, a 100-gallon pump and a 10-inch by 15-foot accumulator will be sufficient. For a large equipment, such as a flanging machine, two riveters, two cranes, two jib cranes and one or two hydraulic punches, there will be required a pump with a capacity of about 120 gallons per minute and a 12-inch by 16-foot accumulator.

The company has built many riveters in which steam or compressed air furnishes the power, and with their wide experience in the building of boiler shop tools of all kinds are prepared to equip plants with high grade machinery exactly adapted to the requirements of their patrons.

An Australian Consolidation Locomotive.

In *Engineering* there appeared recently engravings of a "heavy goods locomotive for the New South Wales government railways," designed by Mr. W. Thow, Chief Mechanical Engineer of that line, and built by Messrs. Beyer, Peacock & Co., Limited, of Manchester. These engravings will be interesting to American engineers, inasmuch as they show the results of experience and study of American engines by an intelligent English engineer and the conclusions which he deduced therefrom. The main features of the engine are American, and many of the details English. As the above title indicates, the engine is of the consolidation type with a Bissel truck; driving wheels, 51 inches diameter; cylinders, 21 by 26 inches; a grate 8 feet 7½ inches long by 3 feet 5¼ inches wide. The frames are, however, of the English plate pattern, the plates being 1¼ inches thick. The fire-box is placed between these frames, which permits it being made somewhat deeper than would be possible if it was placed on top of bar frames after the American fashion, but it is not quite as wide as our fire-boxes are on engines of a similar class.

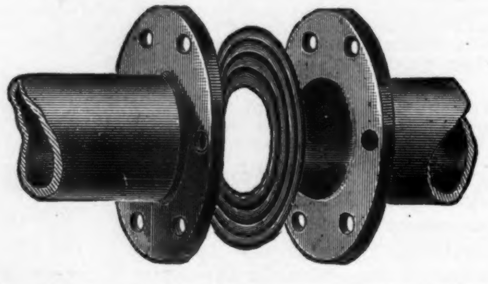
The valve-seats are placed between the cylinders, the valves being vertical and are worked by an Allen straight-link motion. This necessitates bent eccentric rods and a radius rod with a gap in it to clear the front driving axle. The steam passages are very long, and it is thought that in this country the arrangement of steam-chests outside on top of the cylinders and valves, operated by a rocking shaft and ordinary link, would be universally preferred. English engineers almost invariably seem to have an unreasonable prejudice against the use of a rocking shaft. As a matter of fact, there is hardly any working part of an American locomotive which costs so little to maintain or gives so little trouble as a rocker. The truck is distinctly American in design, excepting that Mr. Thow has adhered to his predilections and has used a very small plate frame even on his truck. The steam-chests, being inside, they would come in the way of the truck frame if made in the usual A form. It was therefore necessary to use a single bar for carrying the center pin. This bar is attached to a transverse plate at its front end which does not look like a very secure or strong form of construction.

The springs of the two foremost driving axles are above the boxes, and those over the two hindmost axles are below them. The springs over the front driving axles are connected by a transvere and a central equalizer with the truck. The springs over and below the three rear axles are all connected together by equalizers. The firebox is of the Belpaire type with the crown-sheet slightly arched and inclining downward toward the back. The smallest outside diameter of the boiler is 61¾ inches. The dome is about the middle of the barrel of the boiler and has a safety valve on top. Two other safety valves are placed over the firebox. The latter has a long brick arch below the tubes and extending upward and backward.

Our American builders could, with advantage, imitate the form, size and arrangement of steps on the back end of the engine, and on the tender adjoining.

Corrugated Copper Gaskets.

We show herewith a corrugated copper gasket that is very successfully used in place of rubber or other destructible materials so generally employed for packing. It consists of thin sheet copper stamped with concentric corrugations. Three to six corrugations are all that are necessary, so that the space within the bolt holes usually determines the width of the gasket. In cases where the flanges are thin, and for this reason liable to bend when the bolts are tightened, it is advisable to extend the copper gasket to the



full width of flange. This will, of course, require the cutting of bolt holes in the gasket.

Connections made with these gaskets will not blow out after continued use, for each corrugation makes the entire circle of the flange, and so long as the contact is kept complete by compression the joint cannot leak. It never blows out like rubber. It may be put in place while steam is leaking through the valve. It answers well on pipes in which steam is alternately on and off, for it is not impaired by the repeated expansion and contraction.

It is made not only in the circular form shown, but can be obtained in elliptical and rectangular shapes, in fact, in any desired shape or size. It is for sale by the U. S. Mineral Wool Company, 2 Cortlandt street, New York, and by the Bourne & Knowles Manufacturing Company, Cleveland, O.

The Gas Exposition in New York.

The Gas Exposition held in Madison Square Garden, New York, last month, was a revelation in at least one respect, namely, the brilliancy and beauty of the illumination of the building. Of course electricity was ruled out of this exposition and yet the lighting was all that could be desired. The Welsbach burner was everywhere in evidence and accounted for the brilliancy of the illumination, which certainly could not have been duplicated with gas 10 years ago.

Gas fixtures and gas stoves without number were to be seen among the exhibits and the various uses for gas in exhibiting and lighting were such that one 8-inch and two 6-inch mains were laid into the building. An illuminated tower 60 feet high, representing the development of gas lighting, stood in the center of the hall.

To our readers, the most interesting exhibits were those outside of the domestic uses of gas. The number of gas engines was not numerous, but those shown were interesting. The Pennsylvania Iron Works Company, of Philadelphia, had an attractive exhibit of "Globe" gas and gasoline engines, and one of the gasoline engines of the marine type was shown in position in a handsome launch.

Fairbanks, Morse & Company, of Chicago, exhibited one of their horizontal gas engines, which attracted much attention because of its smooth running and its evident simplicity of construction. The American Motor Company, New York, showed a number of small motors for launches and horseless carriages; and the "New Era," built in Dayton, O., and "Mietz & Weiss" engines were among others shown.

The Safety Car Heating and Lighting Company of New York had an interesting exhibit of Pintsch gas and lamps. One of the lamps for passenger cars was a new design. It is of the inverted argand type, with a clear glass under the burner and a translucent dome through which the ceiling of the car is sufficiently illuminated to do away with all shadows there, while the absence of any obstructions below the reflector avoids the casting of shadows in other directions. The various lamps were arranged so that they could be fed with either Pintsch or city gas at the same pressure. The difference in the illuminating properties was strikingly illustrated. It must have been fully ten times as great with the Pintsch as with the city gas; in fact, there was all the difference between brilliant illumination and next to none. The company also exhibited a gas buoy lantern and a model of a gas buoy. These buoys have been purchased by our government to the number of about 100, and altogether there are about 500 in use in the world for lighting channels. The United States government has recently ordered 14 more of them.

The Continental Iron Works, of Brooklyn, N. Y., had an interesting exhibit. They build large quantities of gas plant machinery and apparatus, but their exhibit was not confined to this. The Morison protected fire door was shown, also a pressed steel furnace front, Morison suspended furnaces, self-sealing mouthpieces for retorts, quick closing gate valves, and several fine samples of welded steel flasks.

The Parker-Russell Mining & Manufacturing Company had an attractive exhibit of fire brick, gas retorts, locomotives, tiles, etc. The Joseph Dixon Crucible Company, Jersey City, exhibited graphite productions of various kinds.

The B. F. Sturtevant Company, of Boston, had an exhibit of blowers and exhausters. What attracted the writer most was a 4 inch by 3 inch double engine such as they make for driving their fans. It was running and was quieter and smoother in its movements than anything we ever saw in the engine line.

The Chapman Valve Company, Boston, had an exhibit of valves; the Wilkraham-Baker Blower Company, Philadelphia, and the P. H. & F. M. Roots Company, Connersville, Ind., each had exhibits of exhausters and blowers. The Armstrong Manufacturing Company, Bridgeport, Conn., had a striking exhibit of pipe fitters tools.

The Jarecki Manufacturing Company, Erie, Pa., had a pipe cutting machine in operation, the Heine Safety Boiler Company a model of their boiler, while the United Gas Improvement Company, of Philadelphia, and Bartlett, Hayward & Company, of Baltimore, each had extensive exhibits of gas plant apparatus.

EQUIPMENT AND MANUFACTURING NOTES.

The Milton Car Works, Milton, Pa., has received orders aggregating 50 tank cars.

The Wells & French Company, of Chicago, are building 100 cars after Santa Fe specifications.

The Commerce Despatch Line has placed an order with the United States Car Company for the repair of 200 cars.

The Drexel journal box and lid is to be used on 100 beef cars of Armor & Company being built by the Wells & French Company.

The Bethlehem Iron Company has received a contract for making the shafting and engine forgings for two big cruisers for the Japanese government.

The Schenectady Locomotive Works have just delivered two new engines to the Texas Midland. These engines are equipped with electric headlights.

The Westinghouse Electric & Manufacturing Company are reported to have secured a contract for 450 electric motors for the West End Electric Railway Company, of Boston.

The Charleston & Western Carolina has placed an order for 18 passenger and baggage cars, 250 box, 50 gondola, 75 flat and 8 caboose cars with the Ohio Falls Car Manufacturing Company.

The mails continue to bring to us calendars for 1897, and, while many of them are handsome, we have voted that none excel that of the Magnolia Metal Company, of 74 Cortlandt street, New York.

The Keystone Gas Engine Company, of New Brighton, Pa., have been incorporated, with a capital stock of $25,000. The directors are Milo A. Shoemaker, Charles W. Shoemaker and William B. Wallis.

The plant of the Ingersoll-Sargeant Drill Company at Easton, Pa., which has been working but five days a week for nearly a year, is now running full time in all departments. A number of foreign orders have been received.

The order of the Texas Midland for three locomotives, placed with the Schenectady Locomotive Works, included one passenger engine with cylinders 17 inches by 24 inches and two freight engines with cylinders 18 inches by 24 inches.

Safety hollow staybolt hose, manufactured by Falls Hollow Staybolt Company, are specified in boilers being built by the Richmond Locomotive and Machine Works for the International & Great Northern Railroad of Palestine, Tex.

The Flint & Pere Marquette Railroad has given a contract to the firm of F. W. Wheeler & Company, West Bay City, Mich., for the construction of another car ferry similar to the one already built by them and illustrated by us last month.

The largest order for locomotives given in some time was received last month by the Richmond Locomotive Works from the Charleston & Western Carolina Railway Company. It was for ten engines with an option for an additional number.

The Fairport Elevator Company have ordered from the Schoen Pressed Steel Company their diamond pressed steel bolsters, both for body and trucks, for the cars now building at the shops of the Missouri Car & Foundry Company at St. Louis, Mo.

The Steel Tired Wheel Company, of New York, has been incorporated at Trenton, N. J. The capital stock is $4,000,000, one-half of the amount being preferred. The incorporators are Hamilton J. Durand, of New York; John J. Tracy, of Jersey City, and Julius F. Workum, of New York.

It is reported that the Providence Steam Engine Company, which built the pair of large Greene engines for the Nantasket Beach power house of the New York, New Haven & Hartford Railroad, has the contract for two Greene cross-compound condensing engines for that company's new station at Berlin, Conn.

The Cleveland Tool & Supply Company, Cleveland, O., have been incorporated, with a capital stock of $20,000. The concern intend to manufacture and sell machinery, machine tools, factory supplies and other iron and steel goods. The incorporators are Frank C. White, F. C. Wittick, M. B. Johnson, Geo. Cook Ford and H. M. Johnson.

The Cleveland Ship Building Company, Cleveland, O., have decided to use Worthington compound independent air pumps and compound boiler feed pumps in the new steamer *Empire City* which they are now building for A. B. Wolvin, of Duluth, Minn. This boat is to be fitted with quadruple expansion engines and Babcock & Wilcox water tube boilers.

An electric lighting and power plant is now being installed in the works of the Schoenberger Steel Company, Pittsburgh, Pa. The plant consists of one 400 horse-power vertical cross-compound engine connected to a 225-kilowatt generator, and one 175 horse-power vertical compound engine connected to a 125- kilowatt generator. The engines were built by the Ball Engine Company, Erie, Pa.

The firm of Jas. P. Marsh & Company, 224 Washington street, Chicago, are doing what they can to disperse the darkness and uncertainty in those engine and boiler-rooms where the light of day seldom enters. They are making a steam gage that can be illuminated from the back, either by an electric light or a gas or oil-lamp. The back of the case consists of a suitable lense that diffuses the light over the entire dial, which is of such a character as to define the figures clearly. The gages are furnished in four sizes, with dials from 6½ to 10 inches in diameter.

Willis Shaw, 506 New York Life Building, Chicago, has just issued a 32-page booklet containing a large list of second-hand boilers, engines, air-compressors, pumps and contractors' appli-

ances. Mr. Shaw has recently furnished a large hoisting engine for the mines of the McLean County Coal Company at Bloomington, Ill., and will put in a pumping plant for the same company. Messrs. W. J. Marson & Company, at St. Johnsville, N. Y., who have one of the contracts for improving the Erie Canal, have placed an order with him for a steam shovel, for use in connection with this work.

Messrs. R. B. Campbell and F. S. Brown announce that they have formed a copartnership in the business of general contracting, succeeding to the business F. S. Brown & Company, of Chicago. It is their intention to handle railroad and public work of every description, making a specialty as heretofore of heavy masonry and substructure work, for which they are well equipped. It will be their aim and endeavor to continue the high standard of workmanship heretofore maintained by the firm of F. S. Brown & Company, and they guarantee satisfaction in every respect in any work with which they are entrusted.

The Barney & Smith Car Company, Dayton, O., is building three trains of vestibuled cars for the Kansas City, Pittsburgh & Gulf. Each train comprises one reclining chair car, one passenger coach and one baggage car, and all the cars are being equipped with Buhoup vestibules, Buhoup-Miller platforms and couplers, Westinghouse air-brakes, Pintsch gas and the Safety Car-Heating and Lighting Company's steam-heat apparatus. The company is also building for the same railroad 100 30-ton box-cars, which are to be equipped with Tower couplers, Westinghouse air-brakes, Chicago Car Roofing Company's "Chicago" roof and McGuire grain doors.

The E. P. Allis Company, Milwaukee, Wis., is completing two large compound vertical beam-blowing engines with high-pressure cylinders 40 inches in diameter, low pressure 78 inches in diameter, [air cylinders each 76 inches in diameter, all by 60-inch stroke. The total shipping weight of each of these engines is over 600,000 pounds. They are for export, and will be shipped to the Krainische Industrie Gesellschaft of Triest, Austria. This concern is the largest iron manufacturing establishment in Austria. The E. P. Allis Company has furnished some 12 engines, duplicates of these, to the Carnegie Steel Company for their furnaces at Duquesne, Pa. The company is also negotiating for a large 1,200-barrel flour mill to be constructed in Braila, Roumania, and W. D. Gray, milling engineer, is now on his way over there for the purpose of closing the deal. The company has also received advices of the completion of a complete concentrating (gold and silver) plant, which was furnished for Jorge Basadre, Tacna, Chili, South America. This concentrating mill is situated 150 miles distant from a railroad and all the machinery had to be transported by mule back.

The Weber Gas and Gasoline Engine Company, of 485 S.W. Boulevard, Kansas City, Mo., are doing quite an extensive export business. Among recent foreign shipments of engines by this firm are: Two Weber gasoline hoisting engines going into the mining country of Kaslo, B. C.; one large size engine to operate a machine shop at Halifax, N. S.; one complete electric light plant, including engines and fixtures, to Merida, Yucatan; duplicate order for two engines for Piræus, Greece. In the United States the company are just finishing the installation of a large amount of irrigation machinery for the Consolidated Canal Company at Mesa, Ariz., and have just completed a large plant for Beyers Bros., of Sugden, Indian Territory, the last named having a capacity of 4,000 gallons of water per minute and the first named 7,500 gallons per minute. Their 1896 design engine is meeting with favor among operators of flour mills, mining machinery, electric light plants and other users of heavy and uniform power ranging from 18 to 50 horse-power. Another of their specialties is a 4 horse-power special agricultural engine, which is designed particularly to meet the wants of farmers, ranchmen, feeders and others requiring a small power for grinding, pumping for small irrigation plants and pumping water for stock supplies.—Iron Age.

The Phosphor-Bronze Smelting Company, Limited, Philadelphia, have issued an interesting little pamphlet on "Delta Metal." This remarkable metal, the pamphlet states, has established an enviable reputation in the military, naval and industrial circles of Great Britain and the Continent of Europe. It is an alloy of copper, combined with other metals in such a manner as to insure perfect regularity of composition and freedom from segregation; the resultant alloy showing great strength, toughness, rigidity and elastic resistance, combined with the desirable property of working hot. The metal is of fine color, does not draw verdigris, and resists the action of corrosion to a remarkable degree; it is particularly dense, and its high elastic limit fits it for the resistance of high pressures, either fluid or gaseous. When exposed to the temperature of high pressure steam its strength is less affected than that of other alloys. It works freely under the tool, does not clog the file, and when finished presents a fine surface susceptible of the highest finish. Delta metal is especially adapted for casting large pieces, such as propellers, gears, plungers, etc.; it can be forged or stamped with the greatest facility, and its qualities may be so regulated as to secure the strength of mild steel or the toughness of wrought iron. It is largely used for propellers and has given highest satisfaction. The company makes several alloys of the same general composition, some intended for castings, others for forged and stamped work, etc. The metal can be rolled or drawn either hot or cold. The pamphlet is embellished with several views or cast, forged and drawn work and a half-tone of a launch built entirely of Delta metal.

Our Directory

OF OFFICIAL CHANGES IN FEBRUARY.

We note the following changes of officers since our last issue. Information relative to such changes is solicicted.

Ann Arbor.—Mr. J. A. Miller has been appointed Purchasing Agent, headquarters at Toledo, O.

Atchison, Topeka & Santa Fe.—Master Mechanic T. Paxton has been transferred from Nickerson, Kan., to Fort Madison, Ia., to succeed Mr. J. Collinson, resigned; Mr. J. E. Gavitt has been appointed Master Mechanic at Nickerson. Mr. G. T. Neubert has been appointed Master Mechanic at Arkansas City, Kan., vice F. G. Tisdale, resigned.

Atlantic Coast Line.—Mr. R. E. Smith has been appointed Superintendent of Motive Power, with office at Wilmington, N. C.

Baltimore & Ohio.—Mr. R. W. Moore has been appointed Master Mechanic of the Pittsburgh Division, vice Mr. T. Trezise, resigned.

Chicago, Rock Island & Pacific.—Mr. J. W. Fitzgibbon has been appointed Assistant Superintendent of Motive Power to succeed Mr. Monkhouse, resigned.

Chicago & West Michigan.—Mr. E. V. R. Thayer has been elected Vice-President.

Georgia & Alabama.—Mr. J. E. Worswick, Master Mechanic at Americus, has resigned.

Grand Trunk.—Mr. Wm. Aird has been appointed Acting Master Mechanic at the Montreal shops.

Great Northwest Central.—Mr. H. F. Forest has been appointed Manager, with headquarters at Brandon, Man.

Greenwood, Anderson & Western.—Mr. C. W. Ward has been appointed Receiver.

Gulf, Colorado & Santa Fe.—Mr. James Collinson has been appointed Superintendent of Motive Power, vice Mr. G. A. Hancock, resigned.

Houston, East & West Texas.—Mr. M. G. Howe has resigned as General Manager, but will continue as Vice-President, and Mr. N. S. Meldrum succeeds him as General Manager.

Lake Superior & Ishpeming.—Mr. H. R. Harris has been appointed General Manager, with headquarters at Marquette, Mich.

Metropolitan Elevated.—Chief Engineer MacAllister has been appointed Receiver.

Oconee & Western.—Mr. R. H. England has been appointed General Manager, with office at Empire, Ga.

Pennsylvania.—President George B. Roberts died last month and the election to fill the vacancy necessitated several other changes so that the offices affected are now filled by the following gentlemen: President, Mr. Frank Thomson; First Vice-President, Mr. John P. Green; Second Vice-President, Mr. Chas. E. Pugh; Third Vice-President, Mr. S. M. Provost; First Assistant to the President, Mr. Samuel Rea; Assistants to the President, Messrs. Wm. A. Patton and E. T. Postlethwaite; Freight Traffic Manager, Mr. Wm. H. Joyce; General Manager, Mr. J. B. Hutchinson.

Pittsburgh & Lake Erie.—Mr. I. M. Schoomaker, formerly Vice-President, has been elected President, and Mr. J. P. Wilson has become Vice-President.

San Francisco & North Pacific.—Mr. A. W. Foster has been elected General Manager, vice Mr. H. C. Whiting, resigned. He continues as President. The office of Superintendent has been abolished. Mr. H. C. Whiting becomes General Superintendent.

Sharpsville.—Mr. G. M. McIlvane has been appointed Receiver.